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Engineering News-Record

WATER-WORKS ISSUE

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Altering the Queen Lane Filters at Philadelphia

A Pavement Breaker for Starting Water-Works Trenches

Plan for Meeting Water-Supply and Sewerage Costs

Coagulation of Water with Alum by Prolonged Agitation

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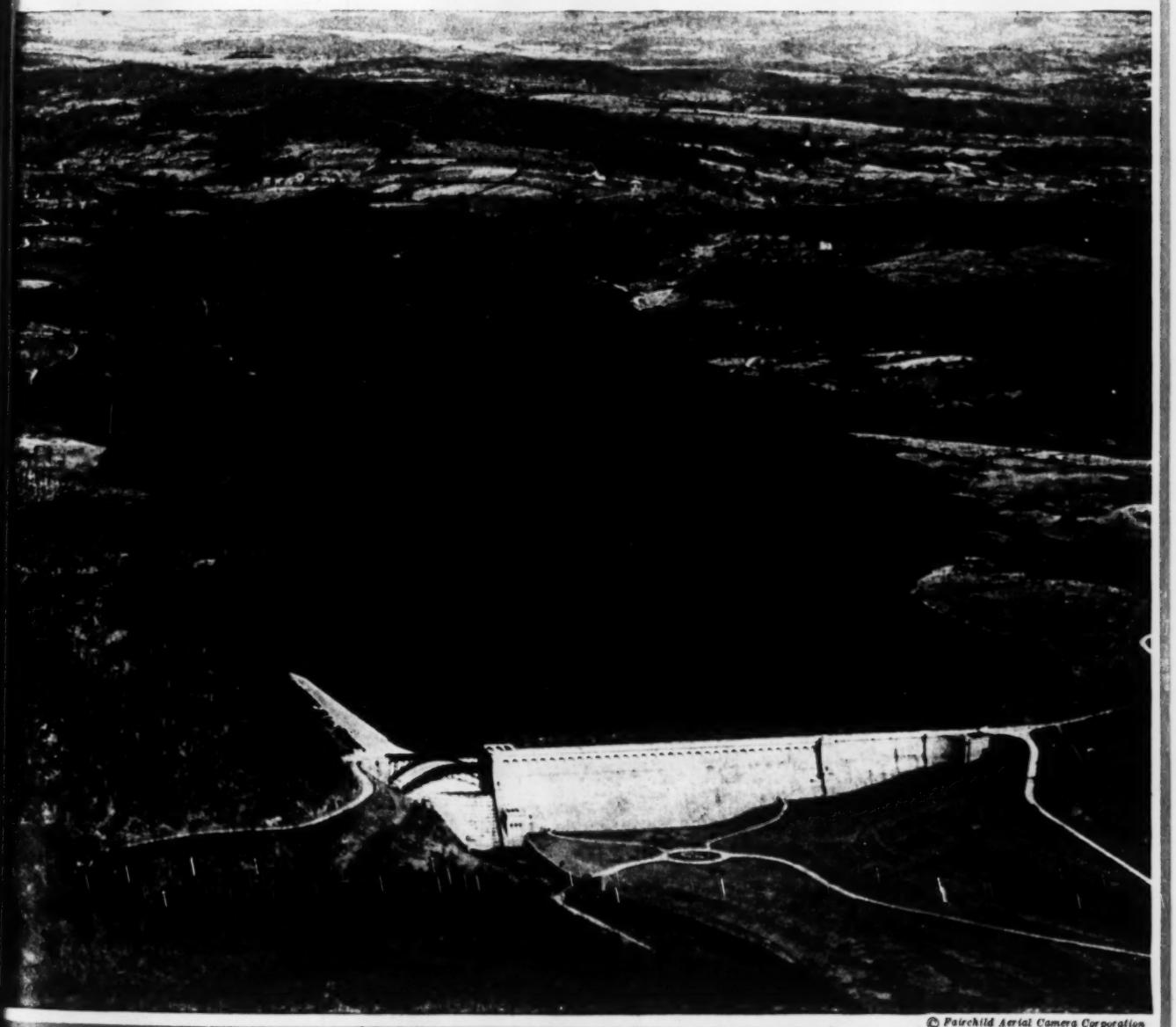

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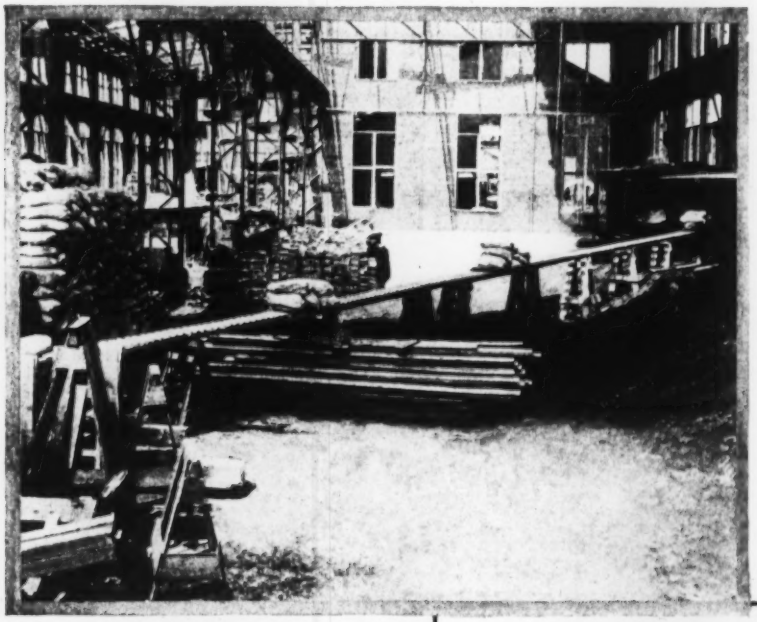

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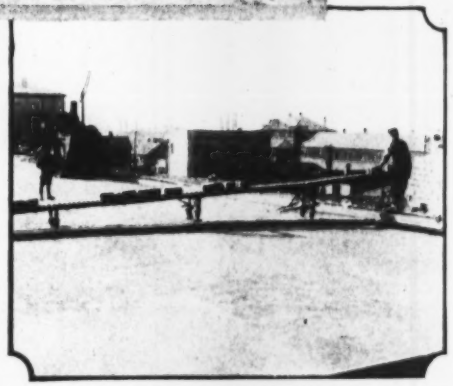

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. Mehren, Editor

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Vital Tests

HOW vital and numerous are the bacterial tests made at well operated water-treatment plants is little appreciated even by the general run of water-works men. The number runs into thousands a year at single plants and upon the care used in making and interpreting the tests largely depends the health of millions of people. Certain questions having arisen as to a new standard for bacterial tests, this journal has made a country-wide survey to find how much this test—the B. Welchii—is used and in what regard it is held. The results of the survey are appropriately presented in this issue which will go to the Cleveland convention of the American Water-Works Association. A variety of other articles that will appeal to water-works men and to broad-minded engineers are printed in this issue.

Gary Hopeful

IT IS generally conceded that the U. S. Steel Corporation is the best managed of our giant industries. In fair weather and foul it has kept on a consistent course, predicated on a thorough understanding of conditions. In consequence Judge Gary's views are accorded unusual weight and attention. Right now, therefore, when business is below normal, it is worth noting the tone of optimism in his address last week before the Iron and Steel Institute. He is not at all discouraged. Business is improving. "Patience, courage and a fair disposition will bring satisfactory conditions in due time." True, others have said these things recently, but it is well to repeat them when so competent an authority holds the same views.

Meeting Water and Sewer Costs

BESET with difficulties to provide money for long over due improvements, as all municipal authorities now are, welcome may be expected for the article presenting a new plan for meeting both capital and operating costs of water and sewer systems, printed on p. 944. The plan is already being applied in Maryland and deserves study and test elsewhere. Its authors consider it applicable to extensions as well as to the new works for which it appears to have been originally designed. A commendable feature is that it presupposes a wide use of meters.

Road-Building Plant

THE principal defects of concrete road construction equipment named by B. H. Piepmeier in the article on p. 949 are that the individual machines break down too easily and are too cumbersome and expensive. Incidentally it is urged that standardization has not been pursued sufficiently. Since they are based on two seasons' observation, these conclusions deserve attention. It is of particular interest to note that a radical change in paving mixer practice is considered important. Small, quick-acting mixers are advocated and the possibility of batch observation during mixing is held essential. In the small mixer, output capacity, heretofore secured by increased size, is to be sought by hastening the mixing operation by a more intensive mixing action. Obviously some nice problems in the mechanics and the commercial manufacture of mixers are introduced by these requirements. Nevertheless it is fairly well known that one large mixer company has long been experimenting with a mixer that would fully meet the requirements laid down. The argument is sound in its broad contention that concrete road-building plants exhibit in practice a haphazard selection and design of equipment units. Some sound study has been given the subject, but there is need for co-ordination, standardization and certainty of operation. Road building deserves more consideration as the routine manufacturing process it is fast becoming.

Controlled Coagulation

MUCH qualitative but little quantitative information is available on the flocculation of turbid waters by aluminum sulphate. Prof. W. F. Langelier (p. 924) finds that the agitation of water with only 0.5 to 0.8 gr. of alum, or half to a third of the usual amount, will, within limits, effect coagulation regardless of the amount of turbidity. Further, that higher alkalinities require more alum; that an acid alum rather than basic upon which operators have always been so insistent, is probably better for most waters; that the higher the velocity of the water in traversing the mixer the speedier the floc forms; that agitation gradually reduced gives better results than violent agitation followed immediately by a comparatively quiescent state. All of these conclusions have market value in dollars and cents in filter-plant design and operation. The experiments on short circuiting of water from inlet to outlet also suggest a promising line of experimentation. Such experiments in large tanks were undertaken at the Spring Garden Testing Station in Philadelphia years ago but unfortunately the results were never made public. Salt was used but was found to have too high a chemical diffusive ability to make the results reliable. The temperature of the water in plain sedimentation basins was found to be one of the most important factors; a warm incoming water could be traced from inlet to outlet by a thermometer. Mechanical agitation would seem to be almost the only method of effective dispersion if approximately complete displacement is to be obtained. Baffling to raise the velocity to a point giving equal results causes heavy expense for constant pumping to overcome loss of head. While Professor Langelier's figures are admittedly tentative they at least reduce the matter to a quantitative basis. The Sacramento results are far reaching but they should be checked by others since some of them are so contrary to generally accepted theory.

Shall B. Welchii Displace or Supplement the B. Coli Water Test?

BETWEEN the water consumer and water-borne disease germs stands the bacteriologist, ever on the alert to detect and to warn of danger. The layman supposes that the water bacteriologist searches for a specific disease germ, but what the water analyst looks for is an indicator of pollution—generally recent pollution—that may be expressed by a quantitative index number, having also some qualitative significance. After years of pure research and of routine water tests the B. Coli test stands today as the accepted standard index of water safety. That a more specific test would be welcomed is no secret but no substitute has yet been found that is so universally available, both as to technique and interpretation.

Of all the substitutes or supplements thus far tried the one that seems to stand out most prominently is the test for B. Welchii in this country and for B. Enteritidis Sporogenes in England—organisms considered by many to be identical or at least unquestionably of the same group of anaerobic spore formers. To learn how widely the B. Welchii test is used, and to get opinions as to its value and also on B. Welchii as a possible cause of water-borne intestinal troubles, *Engineering News-Record* has made a country-wide survey, the first installment of the results of which begins on p. 929 of this issue. That most of the fact and opinions gathered from 66 engineers, bacteriologists and sanitarians are negative as to the value of the test and the danger from this germ is all that needs be said at this point, in view of the summary given in the article.

A remarkable summing up of the case for the B. Coli test, all the more significant here because a number of our correspondents have referred to the use of the B. Welchii equivalent test (B. Sporogenes) in England, and to Sir Alexander Houston (better known to Americans as Dr. A. C. Houston) as a user of the test, is found in his "Water Supply" (London, 1913; p. 168). It reads:

> The B. Coli test is by far the most reliable and speediest method of judging the degree of efficiency of the particular water purification process under investigation, *and when a sterilization treatment is in operation the certified destruction of B. Coli should afford absolute proof, practically speaking, of the devitalization of all the microbes of epidemic water-borne disease.* [Italics ours.—EDITOR.]
>
> All the counts in the indictment charged against the B. Coli test when fully marshalled amount to no more than this: the test is only, or mostly, of relative, not absolute, value, and therefore the results should be interpreted with discretion.

Sir Alexander touches but lightly upon the B. Sporogenes test. If it be urged that the book was written eight years ago, it may be noted that in his Thirteenth Research Report, published in 1920, Dr. Houston summarizes numerous Coli tests of the various London supplies, but no Sporogenes tests.

From all the information we have been able to gather during an inquiry extending over several months we can draw no conclusion that warrants more than the tentative or experimental use of the B. Welchii test, nor the condemnation of a water supply because it sometimes contains B. Welchii.

To accept the assumption that B. Welchii is a water-borne disease germ, as more than one of our correspondents has urged, would lead to nothing short of a revolution in the theory and practice of providing safe water supplies. It would mean millions or billions of added expense for potable water, and that at a time when our typhoid and other vital statistics all point to the practical elimination of water-borne disease wherever sound engineering advice has been followed in the selection of a source of water supply, the provision of purification works, if needed, and in the *maintenance* of the works at a reasonable state of efficiency.

In conclusion, it should be pointed out that with the practical elimination of typhoid, wherever well-accepted principles are followed, an attack may now be made on the occasional and relatively minor intestinal troubles, if it can be shown that these come from water and are due to anything but accidents arising from sheer negligence—accidents that should be eliminated without regard to the main question. No large water-works capital outlays or operating charges will be warranted for an attack on these intestinal disturbances until it can be shown that they are water-borne. Here is an unworked field for health boards and every progressive practicing physician.

Change in Plan of Lockwood Inquiry

THE Lockwood Committee which has been investigating the building situation at New York has abruptly terminated its inquiry into alleged illegal combinations of building materials dealers, producers, and contractors because the committee's counsel, Samuel Untermyer, believes that fines are of no value in breaking up the alleged illegal combinations. The New York judges have been imposing fines instead of sending the guilty to jail.

It is hard to say whether the public is to be congratulated or condoled with because of the termination of this phase of the committee's inquiry. Some good has been accomplished in uncovering bad practices. On the other hand, unwarranted suspicion has been cast on many branches of the construction industry. The procedure has been of a star chamber kind. No evidence in rebuttal was allowed and no cross-examination. Counsel for the committee guided the testimony solely to strengthen the case he desired to make. Such is not the way of justice.

It is significant that two days before the committee's decision to change the course of its inquiry there was heard in New York a defense of the principal business instrumentality attacked by the committee—the open-price association—and the speaker was none other than the Secretary of Commerce. What he said, incidentally, is full endorsement of the position that *Engineering News-Record* has taken upon the usefulness and purpose of open-price associations. Said Mr. Hoover, "Today many students of combinations in restraint of trade are much exercised over the creation of open-price associations, but every single one of these associations that I have been able to investigate originated from the rightful desire on the part of those engaged to secure accurate, complete information on the volume of production, on stocks, on consumption, and on price." The Secretary would undoubtedly admit that these associations may be made a means of circumventing the public, but interchange of price information upon closed transactions furthers the stability of industry and thus proves of general benefit. Their usefulness can be further enhanced, and wrongdoing prevented, if, as this

journal has already pointed out, the statistics that are supplied to members are furnished simultaneously to the public, through the government and the press.

It is further worth while to note that the judge at whose action Mr. Untermyer became incensed made the point, in imposing the fines, that the evidence did not indicate that the public had been harmed. Said Judge Davis, "I have made a thorough examination of the accounts submitted to me—submitted under oath—and I can find no evidence that the defendants have been guilty of profiteering. Nor does it appear that they have made exceptionally large profits as a result of their criminal combinations." Closing his comments he added, "There is absolutely no evidence before the court that in carrying on this illegal combination anybody was coerced or threatened as a means of compulsion."

For one result, aside from the illegal combinations exposed, the Lockwood Committee must be given credit —for shocking into a sense of their responsibility the prominent contractors whose activities gives them a better insight than anyone else into what is going on in the building trade. With them must rest the responsibility for preventing the growth again of the bad conditions disclosed.

Action Needed in Federal Government Reorganization

THOUGH plans for the reorganization of our national government have been under consideration before, no time has ever been as propitious for action as the present. There is a country-wide demand for retrenchment in expenditures, and for a more logical rearrangement of the government's functions. In addition, the war shock and the post-war contraction have created a condition more favorable to change than has existed for many decades.

But there is danger that we may let the golden opportunity slip by. Already it is rumored that Cabinet officers who took their places as professed believers in the need for reorganization are beginning, under the pressure from bureau chiefs, to begin to doubt the need for reorganization, or at least for as extensive changes as they at first believed to be necessary. At best the reorganization job is bound to be beset with difficulties. Bureau chiefs long entrenched have very considerable political influence. Aiding them are tradition and the necessary inertia of a huge government machine. The game of the entrenched forces will be to play for time, and in that game they seem already to be making a score, for it is likely that the Smoot committee on reorganization will not report for a full year. Six months or a year more will be wasted on the legislative dickering, allowing not more than two years for putting into effect whatever plan may be evolved. Even if a good plan is then evolved, enthusiasm for reorganization will have worn off, the Cabinet officers will have fallen into the old line routine—and visions of the more efficiently functioning government will go into the limbo of forgotten campaign aspirations.

"The way to resume is to resume." The way to reorganize is to reorganize. As Edwin F. Gay, of the *New York Evening Post*, has expressed it, it will be a good thing "to smash something quickly, so that a year or more will be required to pick up the pieces." In such a process mistakes will be made, but to have some mistakes is far better than inaction. If we wait for a perfect plan, nothing will ever be done.

The moral of this is that bodies like the Federated American Engineering Societies, which is backing the Department of Public Works idea, industrial associations, civic organizations and influential men generally must bestir themselves and put pressure on Congress to get results quickly. The present enthusiasm for governmental reorganization must be capitalized.

A Presidential Tribute to the Press and to Business

NEVER has the press of America been paid a greater tribute than when, on Monday of last week, the President of the United States, the Vice-President, and the Secretary of Commerce spoke in New York at the banquet in honor of the 125th anniversary of the founding of the *New York Commercial*. With them at the speakers' table were the Secretaries of War and of the Interior. Each of the speakers extolled the work that the press, in general, has done for the country, but the President and Mr. Hoover addressed themselves particularly to the service the business press has rendered.

Business was their topic. They viewed it broadly—as an opportunity for service to the whole community. They related its prosperity and its depressions to the welfare of the people. They argued for stabilizing influences. The Secretary of Commerce enlarged upon the need for "accuracy and completeness of commercial intelligence" for such stabilization. The President declared for such treatment of industry as would encourage its fullest development, while safeguarding the rights of the community. And, after expanding on business development with a vision and a soundness that have been absent from official lips for many a day, they generously laid at the feet of the press, and particularly of the business press, a great measure of credit for the solid things that have been done to develop business along the lines of which they spoke, and to stabilize it in the interests of the whole people.

Their coming to New York, however, developed far beyond a mere occasion for honoring the business press or the press in general. It turned out to be the occasion for giving a new charter to business. The President pictured it not as an object for government persecution and meticulous legislation, but as an essential of national life needing cultivation and encouragement; he held that the business man is not to be prejudged as a criminal and treated accordingly, but one who will respond to an appeal to regard his business not as an instrumentality for personal profit, but as a means of service to the community.

It is recognized that these are high ideals, and that there are those in the business world who will fail to deserve the high confidence thus reposed in them, but as a method of approach to the greatest single, all-pervading influence in our lives, it must be conceded that it is far more certain of getting results than the policy of distrust and suspicion.

In saying, therefore, that the *New York Commercial's* anniversary banquet on May 24 was a signal tribute to the press of America, we must properly add that it was a tribute also to American business. The President's words should prove heartening to those strenuously striving to bring business back to a healthier functioning.

Coagulation of Water with Alum by Prolonged Agitation

Qualitative Data Obtained by Experiment Leads to Redesign of Coagulating Methods for Sacramento Filters—Contrary to Widely Held Theories Prolonged Agitation Is Highly Desirable

By Wilfred F. Langelier

Assistant Professor of Sanitary Engineering, University of California; Consulting Chemist and Bacteriologist, Filtration Division, Sacramento, Cal.

EXPERIMENTS on the coagulation of the turbid waters of the Sacramento River by rapid, controlled, prolonged agitation have resulted in revisions of the early designs for the filtration plant at Sacramento. Briefly, the method of coagulation to which the results led provides for the passage of the treated water through a series of circular tanks, each of which is equipped with a mechanically-driven, rotating paddle capable of imparting to the water a uniform well-ordered rotary motion of an approximately definite and controllable velocity. It is believed that the method possesses marked advantages over the usual method of agitation produced by rapid, but generally non-uniform, flow through a baffle basin. Within reasonable limits the same dosage of alum was found to coagulate water over a considerable range of turbidity and alkalinity; the latter appearing to be the greater factor. Close baffling was found to be nearly as effective as agitation by paddles but it is not so flexible. The higher the velocity the speedier the coagulation. Experiments on short-circuiting in circular tanks, and different arrangements of inlets and outlets, were also made. Several factors influence the effectiveness of coagulation and although much information of a qualitative nature has been accumulated, there seems to be a great need of more precise quantitative data. It is known, for example, that the character of the water as indicated by turbidity, color, alkalinity and colloids, the chemical nature of the coagulant and the method of its application, are all factors which influence the minimum dosage necessary for effective treatment. The relative importance of each factor is not well known because practically all of our observations have been made in connection with existing or experimental plants wherein the scale of operation has been so large as to render adequate control of each factor impossible. With this in mind, experimentation on a purely laboratory scale was begun in the Sanitary Engineering Laboratory at the University of California nearly two years ago. The work is still in progress and although only a few of the factors have been investigated, results have been obtained which are considered significant and which furnish a better understanding of observed phenomena. In addition, similar studies were undertaken last summer in Sacramento in connection with the proposed filtration project for that city. This article discusses primarily these latter studies.

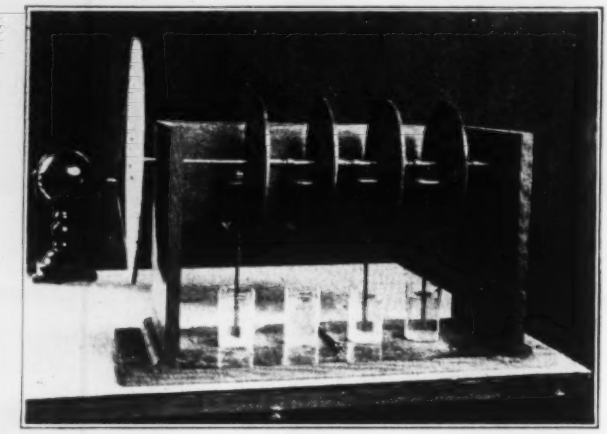


FIG. 1. IMPROVED STIRRING DEVICE WITH VARIABLE SPEEDS FOR STUDY OF COAGULATION PHENOMENON

Perhaps the most important, readily controllable factor in the coagulation of water with alum, and the one about which there seems to be the greatest difference of opinion, is that which relates to mixing or agitation. In plants designed for the use of lime and iron sulphate an extremely rapid and thorough mechanical mixing of the coagulant solution and the water should be thorough and prolonged; whereas plants designed for the use of alum as a coagulant show little uniformity in this regard. The importance of this feature of plant design is pointed out by Ellms in his "Report of Experiments on the Purification of the Milwaukee Water Supply" (1920). After elaborate experimentation, he proposes the "hydraulic jump" as a means of securing adequate mixing. He states that the method "provides an extremely rapid and thorough mechanical mixing of the chemical solution and the water to be treated," and further: "Immediately following the jump the water is allowed to flow quietly to a settling basin in which the physical action of coagulation can take place with the least possible amount of agitation and thereby reduces to a minimum the breaking up of the floc during its formation." Most engineers favor the idea that only the slightest agitation possible is desirable after an initial, reasonably thorough mixing of the alum with the water. This theory is not in accord with any of the experimental data which we have obtained. Our results, checked many times under varying conditions, indicate that prolonged agitation is not only not objectionable, but is highly desirable in increasing the efficiency of the process. A description of the experiments and some discussion follow:

The apparatus used to determine the ideal conditions of agitation consists of a wooden frame on which are mounted four rotating paddles or propellers, each geared to a horizontal shaft driven by a small electric motor. The water is held in cylindrical glass jars 5 in. in diameter and 10 in. deep. A later modification of the device is designed with friction disks which permit the operation of each paddle at a speed independent of the others. The same effect of variable agitation can be produced in the original apparatus by using paddles of different sizes. These simple devices have proved extremely useful in studying coagulation phenomena. Similar apparatus could with profit be included in the laboratory equipment of all water purification plants using coagulation.

With this device the Sacramento River water could be effectively coagulated with dosages of alum varying between 0.5 and 0.8 gr. per gallon for a considerable range in turbidity and alkalinity. Without agitation, other than that required initially to thoroughly mix the coagulant solution with water, these same dosages failed to coagulate the

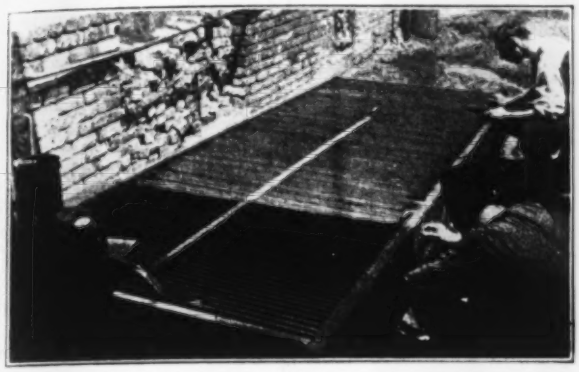


FIG. 2. CLOSELY BAFFLED EXPERIMENTAL COAGULATING BOX

water at all. Observation showed that an increase in turbidity from 20 to 200 p.p.m. had practically no effect on the speed of coagulation, and that but slightly larger doses of coagulant were necessary with the more turbid water to secure the same final clarification. An increase in alkalinity, other conditions remaining constant, necessitated either a more prolonged period of agitation or an increased dosage of alum. The velocity of the water during agitation in the different trials was made to vary. The actual velocities were estimated to range from 0.2 and 1 ft. per second. Later studies showed that velocities up to 2 ft. per second, or even higher, could be prolonged for a considerable period without breaking the floc or reducing the efficiency of the process. In general, the highest velocities produced the most rapid flocculation. The period of agitation in these experiments varied between 10 and 20 minutes.

The description of a simple experiment, the results of which are typical, will furnish a clearer conception of the course of coagulation of a turbid water under varying degrees of agitation. Four thin, clear glass tumblers, each holding 200 c.c. of water having a turbidity of 200 p.p.m. were used. Agitation was produced by paddles of different sizes rotated at 150 r.p.m. Velocities were obtained ranging from a very slow, almost negligible movement in the first jar, up to 3 ft. per second in the fourth jar. Intermediate velocities obtained in the second and third jars were estimated at 0.3 and 1.5 per second respectively. A dosage of 0.3 gr. per gallon of chemically pure aluminum sulphate was added to each jar. Observations of each jar, summarized in the following table, were made at definite time intervals and a number of 1-c.c. samples were withdrawn and observed under the microscope.

CHARACTER OF FLOCCULATION AFTER AGITATION

Time Intervals, Min.	Jar 1	Jar 2	Jar 3	Jar 4
	Estimated Velocities, Feet per Second			
	0.1	0.3	1.5	3.0
5	none	none	just visible	just visible
10	none	none	fair	fair
15	none	none	good	fair
20	none	just visible	excellent	fair
30	none	fair	excellent	fair
50	just visible	good	excellent	fair
70	fair	excellent	excellent	fair
90	fair	excellent	excellent	fair

The results were even more unfavorable than is indicated by the excessive period required for coagulation. Although the character of the flocculation in jar 1 was recorded as fair, the combined efficiency of coagulation and sedimentation was relatively poor, for each particle of floc settled out as soon as it had attained a certain definite size and before coagulation was complete. Under the microscope this floc appeared much more irregular in outline, more fragile and less compact than did the floc from the other test jars. On removing the paddles the floc in jars 2 and 3 settled rapidly, leaving a perfectly clear supernatent water. The rate of sedimentation in jar 4 was lower and the water above was left slightly opalescent. Practically no clarification was produced in jar 1, although the deposit of sediment in the bottom of the jar was nearly as great as in the other jars. Aside from determining the ideal velocity and period of agitation for a given sample of water, this experiment shows clearly that if the velocity is too low, the precipitate of aluminum hydroxide will settle before it has had sufficient opportunity to gather into clusters a maximum number of the fine particles which give the water its turbidity and which it is desired to remove. It is believed that this condition obtains in many existing water purification plants, and that in such instances more adequate baffling would result in greater efficiency and economy of operation.

One of the most important observations that has been made in connection with these studies is the part played by the "reaction" of the water or what chemists term "hydrogen ion concentration." Aluminum hydroxide is least soluble, and consequently most quickly and completely precipitated, in a medium the reaction of which is close to true neutrality. The reaction of raw water is usually alkaline. This, however, depends not merely upon the alkalinity as determined by titration with an acid, but rather upon the ratio of this potential alkalinity to the amount of free carbon dioxide present. With water low in CO_2 the dosage of alum necessarry to produce approximate neutrality is the amount that will

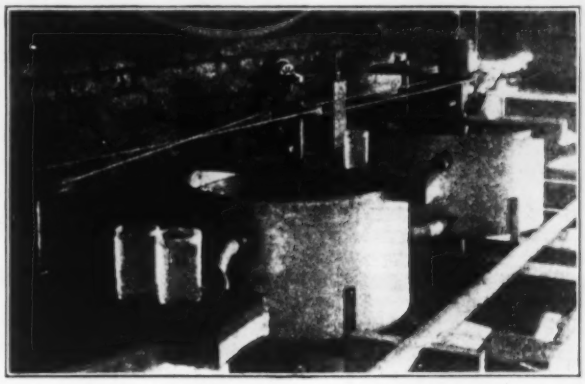


FIG. 3. THIRTY-INCH TANKS FOR CONTINUOUS FLOW OPERATION

reduce the alkalinity one-fifth. Therefore, if the alkalinity of the water is low, the alum necessary to raise the hydrogen ion concentration to approximate true neutrality, and thereby induce rapid precipitation and coagulation, is correspondingly low. It is apparent, then, that more often an acid, rather than a base, should be employed as a means of inducing rapid coagulation with alum. It would appears, moreover, from an extensive series of observations that we must revise our ideas in regard to the desirability of a "basic" alum.

The ideas regarding agitation, which were developed from these earlier experiments in glass jars, seemed to warrant further experimentation on a large scale. It was desired, particularly, to learn whether extensive baffling of a rectangular basin would yield similarly good results and also whether mechanical agitation could be used on a large scale and adapted to the "continuous flow" method of operation. For this purpose a shallow baffle box and a series of circular tanks were constructed. A description of the box and tanks and the experiments follows:

The box was made 4 x 12 ft. in plan and 8 in. deep, and was fitted with 120 crosswise baffles each 1 in. apart. Loss of head occasioned by the passage of the water through the

box (a linear distance of travel of 480 ft.) was partly provided for by supporting the box in a slanting position. The results of coagulation obtained in this box were equal to those obtained in the jars at corresponding velocities (0.1 to 0.2 ft. per second). It was not possible, on account of excessive loss of head, to experiment with the box at the much higher velocities which appeared desirable from the jar experiments. Higher velocities were obtained by the removal of some of the baffles, but this diminished the retention period below the minimum necessary. The results obtained were of such character as to indicate that mixing by this method could be depended upon to produce satisfactory coagulation provided there could be maintained an adequate velocity for a sufficient period of time.

Three 30-gal. galvanized sheet-iron tanks were built and operated in series, with the connections between the tanks made of relatively large diameter (2 in.) in order to maintain a low velocity and preserve the flocs. Each tank was provided with a rectangular rotating paddle 18 in. long (horizontally) by 4 in. wide, fitted to a vertical shaft. The paddles were rotated by means of a system of pulleys operated by a small variable-speed motor. For a time the series of circular tanks was operated in parallel with the baffled box in such a manner as to permit of direct comparison between the two devices.

The results obtained from many trial runs under varying conditions demonstrated conclusively that the very rapid and efficient coagulation obtained in the glass jars could be duplicated in larger tanks provided with mechanical rotary mixing or agitation and operated on a continuous flow basis. With dosages of alum averaging about 0.7 gr. per gallon, an excellent flocculation was obtained repeatedly. The natural turbidity of the raw water at no time exceeded 200 p.p.m., but artificial turbidities up to several hundred parts per million required only a slight increase in alum dosage. The floc particles were of such size that in a sedimentation basin rapid settlement occurred.

Granting that the results obtained by this method are at least as good as can be obtained by the same degree and period of mixing produced in the ordinary way by means of a comparatively rapid flow through a baffled basin, it will be apparent that the method offers at least one very decided advantage, namely, that of greater flexibility. The fact that any desired velocity can thus be maintained, and that this velocity is practically independent of variations in flow through such tanks, would seem of itself to justify a departure from standard practice in the design of coagulating basins. It is believed, moreover, that this type of mixing tank would in many cases eliminate the necessity of a grit basin and the trouble experienced in cleaning a thoroughly baffled mixing basin. No careful estimates of the relative costs of these two types of basins have been prepared, but it is believed that the saving in concrete permitted by the use of relatively thin walls in circular tank construction, together with the elimination of the extensive baffling which otherwise would be required, will more than offset the cost, both investment and operative, of the driving mechanism necessary in connection with the circular tanks, as proposed. The cost of power for operating the paddles should be low. In any event, it should not be much in excess of the cost of delivering water through the additional height necessary to overcome loss of head if baffled mixing basins are used.

The results of these experiments, covering a wide

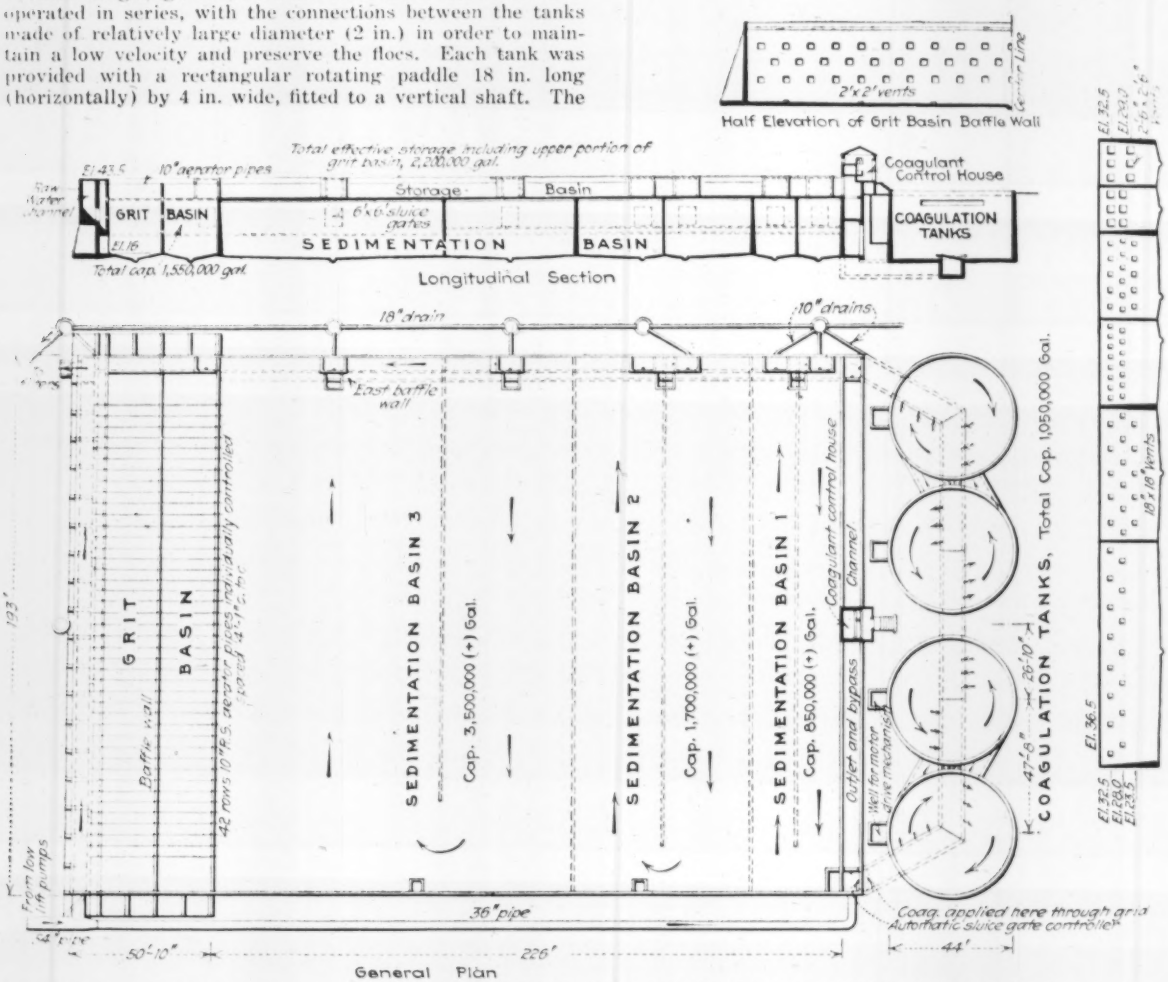


FIG. 4. SACRAMENTO GRIT, STORAGE AND SETTLING BASINS AND COAGULATION TANKS

range of turbidity and alkalinity, have been so consistent, and the conclusions which have been drawn therefrom so rational, that the engineering staff of the Sacramento Filtration Division has redesigned the coagulation and sedimentation features of the new treatment works in that city in complete conformity therewith. These features of the new works had been completely designed on lines more in accord with current practice. Nevertheless, it seemed to be in the interests of efficiency and progress to abandon these earlier designs and to adopt a completely new design, which in many particulars is perhaps without precedent. Certain features of the new design are not related to the utilization of the principles outlined herein. The design of the grit basin with special aërators above it and of a storage basin as an extension of the grit basin, located above the sedimentation basin, has been in a measure induced by local conditions.

Further discussion of some of the more important conclusions developed from these experimental studies, particularly from the standpoint of design, follows:

Number and Capacity of Tanks — For the purposes of design it is necessary to know (1) the period of time necessary to coagulate the given water with a minimum dosage of alum and (2) the extent to which short circuiting is influenced by the tank capacities and the number of tanks used. The former can be determined by simple experiment and the latter can be approximated by computation. Our experiments indicate that in general an actual mixing period of 20 to 30 min. is somewhat more than ample, but on account of short circuiting (which must occur in any type of continuous-flow basin) provision must be made for a somewhat longer theoretical retention period, say 40 min. Our experimental plant was operated on the basis of 40 to 45 min. of theoretical retention. Attempts to determine the extent of short circuiting with the aid of a dye (Uranin) were made, but the results were only partly successful. The time required for a trace of the dye to pass from the inlet of the first tank to the outlet of the last was easily determined, but the proportion of the water that was thus short circuited could not be determined in this manner. It is possible by making certain assumptions (which our dye experiments seemed to indicate as conservative) to compute the proportion of water likely to remain in the tanks a given interval of time for any assumed number of tanks of given capacity. The assumption which it is necessary to make relates to the period of time required for diffusion of a unit volume of water throughout the tank. Under conditions likely to obtain, this may vary from practically zero to perhaps 2 or 3 min. Under the conditions of our experiments, this time interval varied between 1 and 2 min. For the purpose of simplifying the computation, we have assumed an instantaneous diffusion and the results obtained by the proposed formula should be interpreted accordingly

Let Q = Capacity of each tank in gallons.
R = Flow of water in gallons per minute.
n = Number of tanks.
t = Minutes actual retention in n tanks.
x = Proportion of water remaining in tanks t min. (or longer).

$$r = 1 - R/Q$$

Using the above symbols the following relations hold.

r^t = proportion remaining t min. (or longer) if $n = 1$.

$1 - r^t$ = proportion passing in t min. (or less) if $n = 1$.

$1 - (\ )^{\frac{t}{n}}$ = proportion passing first tank in t/n min. (or less).

$\left(1 - (\ )^{\frac{t}{n}}\right)^n$ = proportion passing all tanks in t min. (or less)

$1 - \left(1 - (\ )^{\frac{t}{n}}\right)^n = x$ = proportion remaining in tanks t min. (or longer).

Curves have been prepared to facilitate solving this last equation for different values of r, n and t. From these curves a series of values of x may be obtained for different values of t under any given condition of operation (r and n being constant). Retention period curves computed in this way, for the coagulation basins as designed for Sacramento

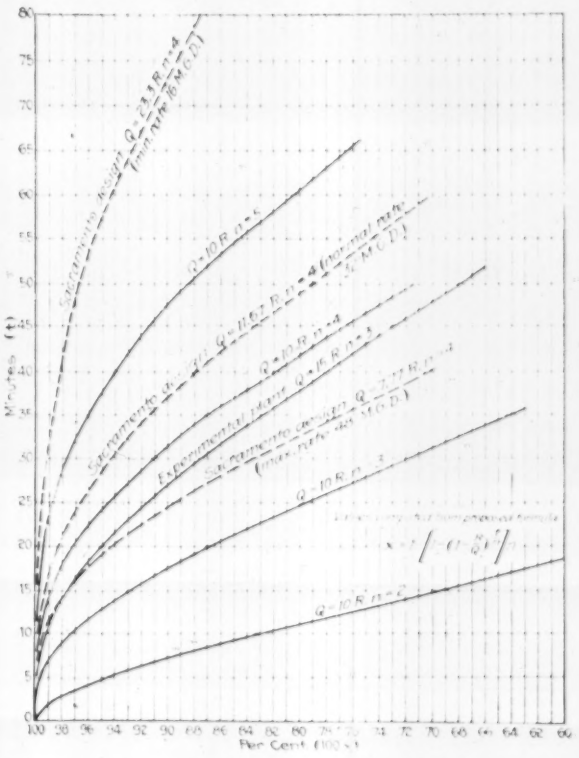


FIG. 5. CURVES SHOWING THE PROPORTION OF WATER RETAINED IN COAGULATION TANKS FOR GIVEN TIME

are shown in Fig. V. The experimental plant curve and also curves satisfying the condition $Q = 10\ R$ for four values of n are included for the purpose of comparison. These curves indicate that the displacement efficiency increases very rapidly with each additional tank, but that good results can reasonably be expected with the use of four tanks if each provides a theoretical retention period of 10 min.

Coagulation and Sedimentation Velocities — Our experimental data indicate that in the coagulation of water with alum, and its subsequent sedimentation, there should be a gradually diminishing velocity throughout the entire period of flow. The initial velocity should be fairly high, say 2 ft. per second. In each succeeding tank the velocity should be reduced gradually until, in the last tanks, the minimum velocity shall be just sufficient to keep all of the floc in suspension. In the sedimentation basin the velocity may properly vary from, say, 0.15 ft. per second at the inlet to perhaps 0.02 ft. per second at the final outlet. The velocities, as given, are substantially those that will obtain under normal operation (32 m.g.d.) in the Sacramento plant. Sedimentation in the Sacramento design is provided for in baffled rectangular basins. There would appear to be no reason why in certain cases circular tanks similar to the coagulation tanks, but with provision for lower velocities, could not also be used for this stage of the process.

Hazen and others have pointed out that clarification by means of sedimentation is independent of the depth of basin, and that floor area rather than retention period is the real criterion of efficiency. Our observations made in connection with the operation of a small and extremely shallow basin confirm this view, but owing to limited data and local conditions with respect to topography and foundation the idea of a relatively shallow sedimentation basin for Sacramento could not be seriously considered.

Inlets, Outlets and Connecting Conduits — The circular coagulation basins recommended permit of a variety of possible inlet and outlet arrangements. Most of our experimental runs were made with simple side inlets and outlets. The water was admitted through a 2-in. circular open-

ing near the bottom on one side and withdrawn through a similar opening on the opposite side near the top. This arrangement seemed to give results equal to those obtained with more complicated center top or bottom inlets. In either case diffusion of the water throughout each tank took place in from 1 to 2 min. Perhaps the simplest and most economical design would provide for the placing of the tanks in contact with one another in such a way as to eliminaet connecting conduits. The Sacramento design is more elaborate but, it is believed, will most effectively reduce short circuiting to a minimum. Whatever arrangement is used, it is important that the water should flow through the tanks without sudden changes in velocity as this may cause a breaking up of the larger particles of floc.

Type of Paddle and Driving Mechanism — The type of agitating mechanism used should be such as to produce as nearly as possible a smooth, uniform motion of the stated velocities. Both high- and low-speed agitators have been considered. It was thought that a flat circular disk revolving at high speed might be preferable to a slowly revolving paddle, such as was used in the experiments, but our general observations indicate that any high-speed device would break up the floc and therefore would be objectionable.

The Sacramento studies in coagulation were made under the direction of Prof. Charles Gilman Hyde, consulting engineer, and C. G. Gillespie, resident engineer of the Sacramento Filtration Division. Other members of the engineering staff, notably H. B. Foster and Harry N. Jenks, have been intimately connected with the work. The latter was in charge of the experimental plant during the last few weeks of its operation and secured many of the operating data which have been used in the design of the coagulation and sedimentation basins. The mechanical features of agitation are being investigated by Prof. B. F. Raber, assistant mechanical and electrical engineer.

The General Contractor

Extract from an address delivered at the dinner of the executive board, Associated General Contractors, and guests, Washington, D. C., May 10, by W. O. Winston, president.

THE general contractor, in common with the engineer, architect, mechanic and laborer, is a cog in a machine that makes for civilization and progress. He is both proud and happy to be in such company for such work. He is not concerned whether his cog be large or small, but whether it be large or whether it be small, he is concerned in having it so function that the master may say, "Well done, good and faithful cog."

In a nutshell, it is the rule and not the exception that the first concern of the general contractor is for his reputation — reputation for skill and integrity — realizing that on that, more than on anything else, depends not only his success, but his happiness in business.

And now for a few minutes I shall speak about some things which are not germane to my text.

The construction game is not what it was when I sat in some forty-five years ago. The cards are different, the rules are different, and, speaking generally, the players are cleaner and squarer. In this time I have seen the steam shovel take the place of the pick and shovel, locomotives and cars of large capacity take the place of the wheelbarrow and the horse cart, and so on down the line. Through the instrumentality of these improved implements of construction, it is possible to do in three months now what would have taken twelve months then, and yet it will surprise many of you when I say that the unit cost of work has increased rather than decreased.

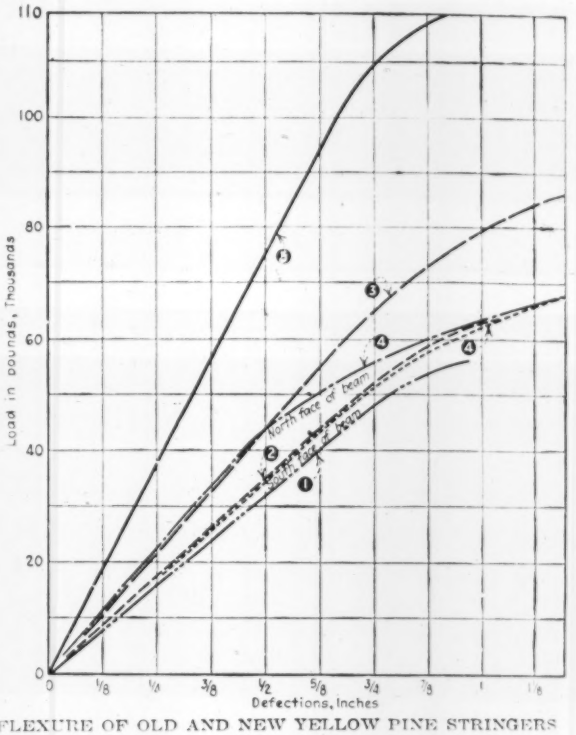
Fifty years ago, at least in the state of my birth, contracting was not considered to be a vocation of a gentleman. It was work for the roughneck and overseer. But now there as well as elsewhere, it is an honorable profession, second to none

It is distinctly a creative and strenuous profession and that is why it appeals so strongly as it does to men of vision, courage and guts.

Tests of Timber Dock Stringers

By M. O. Fuller
Asst. Professor of Civil Engineering, Lehigh University, Bethlehem, Pa.

RECENT tests of old creosoted pine stringers that had been in service for about 34 years have shown good records of strength. Two stringers were taken from a dock of the Lehigh Valley R.R. at Perth Amboy, N. J., being southern yellow pine timbers creosoted in 1886 by the railroad and in service from 1886 or 1887 to October, 1920. The timbers were in fairly good condition, showing the beneficial results of the creosoting treatment. A new untreated yellow pine timber was tested at the same time. These tests were made at the Fritz Engineering Laboratory of Lehigh University, Bethlehem, Pa.



FLEXURE OF OLD AND NEW YELLOW PINE STRINGERS

Beams Nos. 1 and 4 were originally one piece, as also Nos. 2 and 3. The specimens were placed in the 300,000-lb. Olsen testing machine, the loads on Nos. 1, 2 and 3 being applied at the same points as in service. No. 4 was tested with third point loading. No. 5, the new untreated stringer, was tested the same as Nos. 1, 2 and 3. Deflection readings were taken at the point of maximum deflection and then these readings were plotted against the loads. The load at the yield point was determined from the curve and the stress then computed.

FLEXURE TESTS OF YELLOW PINE STRINGERS

	Old Creosoted Timbers				New Untreated Timber
	1	2	3	4	5
Breadth, in.	7¼	7¼	7¼	7¼	8¼
Depth, in.	15	14½	14½	15	16
Span, ft.	12	11½	11½	11½	11½
Yield pt. from curve, lb.	48,000	50,000	60,000	40,000	Not reached
Do., lb. per sq.in.	3,500	3,800	4,600	3,200	Not reached
Max. load, lb	58,500	64,370	86,500	68,750	119,750
Mod. of rupture, lb. per sq.in.	4,300	4,900	6,700	5,400	6,600
Max. total shear at failure lb.	35,950	39,880	53,590	34,370	74,190
Ave. unit shear, lb. per sq.in.	309	366	501	295	545
Max. hor. shear, lb. per sq.in.	454	549	751	443	817
Failure	Tension	Tension	Tension	Hor. shr.	Hor. shr

B. Welchii As Test for Safe Water and Cause of Water-Borne Diarrhea

Survey Shows Only One Laboratory that Condemns Water on B. Welchii Finding, One Using Test for Comparison and a Few Occasionally—No Proof that B. Welchii Cause Intestinal Outbreaks

B. WELCHII tests of the filtered and chlorinated water supplied to Montclair, N. J., from the Little Falls plant of the Montclair and East Jersey Water companies figured last year in expert testimony on the quality of the water and this year in repeated advice by the Montclair Board of Health that the water be boiled before use for drinking. Officially, semi-officially and otherwise a campaign of condemnation of the supply has been conducted. The use of bottled waters and waters from local wells and springs, after certification by the health officer, has been encouraged. B. Welchii has been held up as a cause of water-borne diarrhea. In view of the part that the B. Welchii test has played in this campaign against water from one of the best known and most highly regarded water purification plants in the country and the far-reaching questions that the incident raises as to the safety of filtered and chlorinated waters in general and as to the sufficiency of the standard B. Coli test, *Engineering News-Record* has made and here summarizes a country-wide survey of the use of the B. Welchii test and of opinions as to B. Welchii as a possible cause of intestinal disturbances other than typhoid fever. Most of the replies are negative or doubtful. Nearly all show great interest in the subject. Many indicate the desirability of further study—at least of the anaerobic spore formers.

Experts in the Montclair Case

Experts testifying either in favor of the B. Welchii test or against the quality of the Montclair water, or both, were the late Prof. W. T. Sedgwick, Prof. M. J. Rosenau, Earl B. Phelps and Charles E. North, all in support of an application by the Montclair Town Commission to the State Conservation and Development Commission for a permit to take water from Split Rock Pond. Following the denial of the permit, the re-establishment of the Montclair Board of Health, the engagement of H. B. Larner as health officer, and the re-opening and expansion of the health board laboratory, daily tests for both B. Coli and B. Welchii were begun about December, 1920, and have been continued since. Although the B. Coli tests have rarely been positive, B. Welchii were indicated from time to time, notably after cold spells. In mid-February, a telephone canvass of physicians disclosed 187 cases of diarrhea in Montclair—in a population of 30,000 or less. The B. Welchii findings, the earlier allegations as to the pollution of the water supply, the diarrhea cases, not only in 1921, but also an outbreak of some 1,625 cases three years earlier, led to the circulation of a notice that all water used for drinking and cooking be boiled for 30 minutes. This advice has been renewed from time to time, on the strength of occasional findings of B. Welchii. The earlier diarrhea outbreak mentioned was attributed to the dislodgement of deposits in the 51-in. feed main supplying Montclair and other communities, due to a 50 per cent increase of velocity caused by war emergency and cold weather consumption demands. At the same time, it is understood, the filters were by-passed, so that for some weeks water that had been chlorinated only, was supplied. Montclair and Glen Ridge, which got the first dose of the water under the conditions named, were the chief sufferers from the outbreak. It may be added that for years past there has been very little typhoid in Montclair—no deaths for more than three years; only three cases in 1920, all "contracted out of town" and only two cases thus far in 1921.

The 66 replies to our B. Welchii inquiries (nearly every one appealed to replied) have been tabulated in three groups: (1) Federal and state health authorities; (2) Water-works and board of health laboratories; (3) Private laboratories and consulting sanitarians. Numerous supplementary statements, some of much length, are given.

Results of Survey Are Given in Brief

Briefly, the replies, which come from Massachusetts to California, and Ontario to Texas, show that Montclair stands alone in depending upon the B. Welchii test as index of the safety of its water supply and almost alone in holding that there is a proved relationship between B. Welchii and intestinal outbreaks. Jersey City, after a period of occasional use, has tested for B. Welchii since Montclair citizens were advised to boil their water, but this is due to the feeling of Dr. McLaughlin that since Jersey City has a supplementary supply from the same source as Montclair it is desirable to be able to make B. Welchii comparisons between the filtered and chlorinated Passaic water and the regular main supply from the Rockaway (a tributary of the Passaic), which is chlorinated only. The only report of any extensive series of B. Welchii tests is from Dr. Hale, New York City, in 1917-19, but he now uses brilliant green to eliminate B. Welchii from interference in the B. Coli presumptive test. A few others report that the B. Welchii test is or has been made occasionally and two or three hope to make it. To save repetition and space, a number of statements of lack of knowledge of the use of the test in America have been omitted, as well as some references to its known use in England (under the name B. Sporogenes or B. Sporogenes Enteritidis). For the same reason, many detailed expressions of doubt as to the value of the test, or as to B. Welchii causing diarrhea, have been omitted.

Much of the omitted opinion appears to be based on data presented by Dr. J. P. Simonds in a monograph presented in 1914 to the Rockefeller Institute of Medical Research and published by the Institute in 1915 as "Studies in Bacillus Welchii, with Special Reference to Its Classification and Its Relation to Diarrhea." (Unfortunately out of print.) It should be noted that this monograph contains neither specific mention nor even a hint that diarrhea is water borne, whether caused by B. Welchii or otherwise.

Without attempting to distinguish between facts and opinions on B. Welchii given by Dr. Simonds and by our own correspondents the following highly condensed summary is given: B. Welchii is widely distributed in

USE OF THE B. WELCHII TEST FOR THE SANITARY CONTROL OF PUBLIC WATER SUPPLIES AN

1. The Federal and State Health Services		— B. Welchii Test — Made*	Advisable*	Cause of Intestinal Trouble*
U. S.:	*Dr. R. H. Creel*, Asst. Surg. Gen., Pub. Health Serv., Washington, D. C.	No	.....	.....
	Dr. G. W. McCoy, Dir. Hyg. Lab.	.....	.....	Doubtful
ME.:	*P. C. McGouldrick*, Dir. Lab. Augusta	No data	No data	No data
VT.:	*H. B. Stone*, Dir. Lab., Burl'n	No	No	.....
MASS.:	*H. W. Clark*, Dir. & Chem., W. & S. Lab., Boston	Sometimes [2]	Occasionally	.....
R. I.:	*S. De M. Gage*, Chem. & San. Engr., Providence	No	No [3]	Not proven
CONN.:	*J. F. Jackson*, Dir. Bu. Eng., Hartford	No	No [4]	.....
N. Y.:	*T. Horton*, Chf. Engr., Albany..	No	Not proven [5]	Not proven [5]
	W. F. Wells, Biol. & Sanit'n, Cons'n Com., Albany	In past	Not yet [6]	Not proven [6]
N. J.:	*R. B. Fitz Randolph*, Chf. of Lab., Trenton	No	Proposed [7]	Not proven [7]
PA.:	*C. A. Emerson, Jr.*, Chf. Engr., Harrisburg	No	Prefer Coli-Aerog. Group [8]	Not proven [8]
DEL.:	*C. H. Wells*, Spec. H. Comr., Wilmington	No	.....	No proof [9]
MD.:	*R. B. Morse*, Chf. Engr., Balt.	No	No [10]	Not proven [10]
VA.:	*R. Messer*, Chf. Engr., Richm'nd	No	.....	.....
W.VA.:	*E. S. Teasdale*, Chf. Engr., Charleston	No	No data	No data
N.C.:	*J. W. Kellogg*, State Lab. Hyg., Raleigh	No	No	No evidence
S. C.:	*Dr. F. A. Coward*, in Chg. Lab., Columbia	Once	Sometimes as adjunct	Debatable [11]
	E. L. Silby, San. Engr., Columbia	.....	Possibly with B. Coli [12]	.....
FLA.:	*G. W. Simons, Jr.*, San. Engr., Jacksonville	No	.....	Not proven
ALA.:	*G. H. Hazelhurst*, Chf. San. Engr., Montgomery	No	Doubtful	Not proven
LA.:	*J. H. O'Neill*, San. Engr., N.O.	No [13]	.....	Probable [13]
OHIO:	*W. H. Dittoe*, Chf. Engr., Col.	No [14]	No [14]	.....
MICH.:	*C. C. Young*, Dir. Lab., Lansing	Sometimes [15]	Valuable adjunct	.....
ILL.:	*H. F. Ferguson*, Chf. San Engr., & *M. W. Cowles*, Analyst, Dept. Pub. Health	Few special studies [15a]	.....	No conclusion reached [15a]
	Miss M. Perry, Bact., State W. Surv., Urbana	No	May study	.....
WIS.:	*C. M. Baker*, State San Engr., Madison	No	.....	.....
IOWA:	*J. J. Hinman, Jr.*, Water Analyst, Iowa City	No [16]	Doubtful [16]	Doubtful [16]
MINN.:	*H. W. Whittaker*, Dir. Div. San., Minneapolis	No	.....	.....
	Dr. A. J. Chesley, Act'g Ex. Off., Div. Prev. Diseases	No	.....	See note [17]
TEX.:	*Dr. M. Graham*, Bacteriologist	No	No	No proof
CAL.:	*Ralph Hilscher*, Dir. Bu. San. Eng., Sacramento	Once [18]	.....	.....

2. Water-Works and City Board of Health Laboratories		— B. Welchii Test — Made*	Advisable*	Cause of Intestinal Trouble*
NEW YORK CITY:	*Dr. W. H. Park*, Bd. of H. Lab.	No [19]	Doubtful [19]	.....
	Dr. F. E. Hale, Dir. Lab., Dept. W. Sup.	In past [20]	No	.....
JERSEY CITY:	*Dr. G. E. McLaughlin*, San. Adv. & Bact., Bu. Water	Yes [21]	See note [21]	Not proven [21]
MONTCLAIR, N. J.:	*H. B. Larner*, Health Officer	Yes	Yes	Yes
TRENTON, N. J.:	*F. W. Daggett*, Supt. Filtration	No	No	.....
PHILAD'A:	*C. E. Davis*, Chf. Bu. Water	No	.....	.....
	J. A. Vogelson, Chf. Bu. Health	No	.....	.....
BALTIMORE:	*J. W. Armstrong*, F'n Engr	Sometimes [22]	.....	.....
	Dr. W. R. Stokes, Dir. Bu. Bact., Health Dept.	No	.....	No proof
PITTSBURGH:	*W. C. U. Bates*, Chf. Analyst, Bu. Water	No [23]	No	No
CINCINNATI:	*C. Buhlman*, Chf. Bact., F'n plant	No [24]	See note [24]	.....
COLUMBUS:	*C. P. Hoover*, Chem. in Chg. F'n	No [25]	See note [25]	.....
INDIANAPOLIS:	*H. E. Jordan*, Supt. Filtration	No [26]	See note [26]	.....
CHICAGO:	*Dr. J. D. Robertson*, Comr. Health	Sometimes [27]	See note [27]	.....
MILWAUKEE:	*Dr. G. C. Ruhland*, Comr. Health	Sometimes [28]	.....	.....
MINN'LIS:	*L. I. Birdsall*, Supt. F'n	No	Doubtful [29]	Not proven
ST. LOUIS:	*A. V. Graf*, Chem. W. Div.	Sometimes [30]	Doubtful [30]	Not proven [30]
TORONTO:	*N. J. Howard*, Bact. Water F'n Plant	No [31]	No [31]	.....

1. *McCoy*—Most of the evidence seems to show lack of correlation of B. Welchii with water-borne intestinal troubles. The usual presence of the organism in normal stools in considerable numbers must be considered.

2. *Clark*—About six years ago we studied the B. Welchii test quite extensively. It did not seem to pay for the extra work. In the past two years we have made occasional B. Welchii and B. Coli comparisons in such waters as the filtered Lawrence supply and once or twice in connection with intestinal outbreaks thought to be due to water but we have seldom found B. Welchii and do not seem to have gained much information. The test may occasionally be of value in connection with others.

3. *Gage*—So long as we lack a proved relationship between B. Welchii and water-borne intestinal troubles I do not see the wisdom of adding this test to our routine or substituting it for the B. Coli test.

4. *Jackson* — Until our knowledge of the B. Welchii organism is more complete, I very much doubt if it will be used generally as a substitute for the B. Coli test.

5. *Horton*—The more I study outbreaks of gastroenteritis the more I am convinced that most of them, at least, are water-borne. Whether it is infection by B. Welchii or some other bacterium, or infection by a protozoan, or whether the trouble is due to irritation from physical, chemical or organic substances I do not know, but I am inclined to think that a specific organism is the cause. It seems to me that much bacterial work would have to be done, not only regularly, but also during epidemics of gastro-enteritis, thereby showing the distinctive prevalence of B. Welchii during epidemics, to substantiate the B. Welchii theory. If it should be found that B. Welchii, B Coli and a high total bacterial count are coexistent it might not be necessary to multiply our technique, to determine pollution. Studies of the subject might well be made by the U. S. Public Health Service or by some of the state health departments equipped for research work.

7. *Fitz Randolph*—We do not propose to make routine B. Welchii tests unless it can be shown much more clearly than has yet been done that the germ in water indicates danger to health. We plan B. Welchii tests of some of our water supplies. This will take some time to complete, but I think will give us information of value. Any surface water from an inhabited watershed may be expected to show spores of B. Welchii at times. These spores are resistant to heat and, so far as I can ascertain, are not destroyed by chlorination at ordinary rates. Being small, some B. Welchii spores will pass through an ordinary rapid sand filter. Therefore it is to be expected that a filtered and chlorinated water from a rather thickly populated watershed, on which are a number of sewage disposal plants, will sometimes show B. Welchii. B. Welchii in filtered and chlorinated water, like chlorine above normal, indicates past pollution but throws little light upon purificant plant efficiency.

8. *Emerson*—We make routine tests for the Co'i-Aerogenes group, as preferable to the specific test for B. Welchii. Quite frequently, in surface waters, the Aerogenes group is found when B. Coli is absent in differential examinations. We consider such supplies doubtful but feel that further studies should be made before either approving or condemning a supply—such as checking physical field investigations, additional analyses or both. Usually in dysentery outbreaks we have been able to find rather definite causes, either by physical examination or by establishing a field laboratory on the site and searching for the specific dysentery bacteria.

9. *C. H. Wells*—If a water contains B. Welchii in considerable numbers it would be reasonable to suppose that intestinal troubles in the community using it were caused by the water. In such a case the stools of some of the patients might well be examined to find the predominating type of organism or at least whether it resembles those found in the water.

10. *Morse*—The B. Welchii test has so many difficulties in technique that its adoption is not likely to be general. It often seems more reasonable to attribute intestinal outbreaks to anaerobes in milk rather than in water supplies. In most of the apparently water-borne gastro-intestional outbreaks, the poor condition of the water supply has been reflected in the current B. Coli tests. At Camp Meade, several years ago, it was reported that B. Coli tests gave no evidence against the water yet B. Dysentery (either Flexner or Shiga type) was isolated from the water.

11. *Dr. F. A. Coward*—Sometimes the B. Welchii test would be a valuable adjunct but it could not safely displace the routine official test. Four or five years ago at Abbeville, S. C., there was a very mild epidemic of a peculiar diarrhea, resembling sprue. I found B. Welchii in stools at the decline of the epidemic, which was self-limited. Epidemiological study, by exclusion, pointed to the city water supply.

12. *Silby*—Since B. Coli and B. Aerogenes are often confused, tests for B. Welchii might be employed in addition to B. Coli. In a recent investigation at Greenville, S. C., the varied and confusing.

13. *O'Neill*—In the summer of 1919, by request, the city bacteriologist of Shreveport tested for B. Welchii and found it in the Red River and Bayou water after rapid filtration and liquid chlorination. B. Coli is seldom found in the treated supply, but a large number of samples examined ferment lactose on the presumptive test. I believe there is some relation between these lactose fermenting organisms (probably in many cases B. Welchii) and the incidence of enteric diseases other than typhoid, but I have no definite data.

14. *Dittoe*—We believe no gas formers should be found in 10 c.c. of filtered or ground waters. In field work we make the presumptive test only, but in the laboratory partly confirmed tests are made. We do not think it is necessary to differentiate between B. Coli and B. Welchii, as either form would cause gas in broth incubation and indicate an unsatisfactory water. With a surface water we might, in a particular case, differentiate gas producing organisms but ordinarily, even in such cases, we would accept gas formers as confirmation of findings based on sanitary examination.

15. *Young*—We occasionally look for the B. Welchii group when the B. Coli test is negative but anaerobic gas formers are present.

17. *Chesley*—Last year there was considerable intestinal trouble in Minnesota, both where the water was and was not chlorinated.

18. *Hilscher*—The only study B. Welchii in California that has come to my attention was at Sacramento about four years ago. [See statement from F. Bachman.—EDITOR.]

19. *Park*—My impression is that B. Coli is as good an indication of water pollution as any other organism.

21. *McLaughlin*—For some two years before Jan. 1, 1921, I made tests for B. Welchii in fermentation tubes showing gas but which did not plate positively for B. Coli on endo; that is, where fermenting aerobic bacteria were suggested. Since Jan. 1, I have

OPINIONS ON THE RELATION OF THE ORGANISM TO WATER-BORNE INTESTINAL TROUBLES

3. Private Laboratories and Sanitarians	B. Welchii Test—Made*	B. Welchii Test—Advisable*	Cause of Intestinal Trouble*
S. C. Prescott: Prof. Ind. Biol., Dept. Biol. & Pub. Health, M.I.T. Cambridge	Sometimes	In addition to B. Coli [32]	Possibly [32]
M. J. Rosenau: Prof. Prevent. Med. & Pub. Health, Har. Univ. Med. School, Boston	.....	Probably index like Coli [33]	Uncertain [33]
E. S. Weston: San. Engr., Boston	In past [34]	Probably [34]	.....
M. C. Whipple: Instructor San. Chem., Eng. School, Harv. Univ. Cambridge	Have used [35]	No	.....
Frank Bachman: Chem. Engr., Dorr Co., New York City	In past [36]	Doubtful [36]	Doubtful [36]
W. S. Cyalter: Con. Engr., N. Y. City	In past [37]	Doubtful [37]	Not proven [37]
N. S. Hill: Consult. Engr., N. Y. City	Sometimes [38]	Sometimes [38]	Not proven [38]
D. D. Jackson: Prof. Chem. Eng., Columbia Univ., N. Y. City	Yes [39]	Yes [39]	Yes [39]
G. A. Soper: Consult. Engr., N. Y. City.	.....	Scientific [40]	.....
Dr. H. D. Pease: N. Y. City	See note [41]	See note [41]	Not proven
J. M. Caird: Chem. & Bact., Troy, N. Y.	No	No	No
Dr. W. W. Ford: Assoc. Prof. Bact., Johns Hopkins School Hyg. & Pub. H., Baltimore	Sometimes [42]	No [42]	No [42]
J. W. Ellms: San. Engr., Cleveland, O.	No	See note [43]	See note [43]
Dr. R. S. Perkins: Dept. Hyg. & Bact., School of Med., Wn. Res. Univ., Cleveland	.....	Doubtful [44]	No more than B. Coli [44]
Dr. E. O. Jordan: Prof. Hyg. & Bact., Univ. Chicago	.....	Doubtful [45]	Doubtful [45]
M. F. Stein: Civil Engineer, Chicago [46]	No	For Filt. & Chlor. W [46]	.....
Mac Le ine: Assoc. Prof. Dept. Bact. & Hyg., Ia. State Col., Ames	No [47]	No	Doubtful
W. F. Monfort: Consult. Chem., St. Louis	No indication of use in this section.		

* Responsibility for condensing some long statements to a word or two rests with the Editor. In many cases more detailed statements are given in the text.

made B. Welchii tests regularly on both our Rockaway and our supplementary Passaic supply from the East Jersey Water Co. I have tested the Passaic supply because of Montclair's claims of finding B. Welchii in the same water. The tests of both supplies are made more to compare the two waters than because I attach any great value to finding B. Welchii, for at most I regard this organism as indicating remote pollution. I believe our B. Welchii test is fairly accurate for our purpose, but it does not show which of the many strains of B. Welchii is present nor whether the one found is pathogenic. The latter determination would entail considerable work and is unnecessary unless there is some decided reason for it. B. Welchii has been found in our Rockaway water at times, but as it seems to be incapable of producing ill effects, at least in our chlorinated water, it does not appear to be of much importance compared with B. Coli. All attempts of which I know to produce diarrhea by feeding cultures of B. Welchii have met with little or no success. The germ is present in a large percentage of milk samples tested, but I am aware of no epidemic of diarrhea proved to be due to B. Welchii. As to B. Welchii being a cause of disease when found in water supplies my opinion is "not proven."

22. *Armstrong*—On a number of occasions we have found B. Welchii in our raw water in large numbers, but the test has been too infrequent to draw conclusions as to the effect of the germ upon potable water.

24. *Bahlman*—For the last three years we have been differentiating B. Coli into the so-called fecal and non-fecal types (the Methyl red test). Beginning Jan. 1, 1921, we have elaborated these tests and are now using, besides the Methyl red test, the Voges-Proskaur reaction and also studying the correlation of these tests with growth or non-growth in Koser's uric acid medium. This work will give us an idea of the relative proportion of typical B. Coli, B. Aerogenes, and allied bacteria in our water. Probably we will consider B. Welchii tests at some future time, but it will be at least a year before any results of our work can be summarized.

25. *Hoover*—It is our policy to remove all gas-forming bacteria and we believe this is possible in any well equipped water purification plant. I think many water filters are being used simply as strainers, dependence for satisfactory bacterial results being placed on chlorination. The policy at most of the filter plants in Ohio is different. A filter plant is supposed to produce a filtered water of such purity that four out of five 10-c.c. portions give negative Coli results. Such a water, treated with from 0.3 to 0.5 p.p.m. chlorine, should be free from all gas-producing bacteria and absolutely safe.

27. *Robertson*—Since Jan. 1, our laboratory has made a few B. Welchii tests, so far with negative results.

28. *Ruhland* — Our routine practice is to test for B. Coli. We are making tests for B. Welchii whenever the water shows considerable fermentation, or when there is an increased report of cases of intestinal trouble. B. Welchii is not so frequently found here as are members of the colon dysentery group. We are now running a culture on which we are about to make the agglutination test to determine identity.

In our heavily contaminated lake water we have found quite a variety of pathogenic organisms. Among these are B. Coli, B. Subtilis, B. Sporogenes, Staphylococcus Aurea, Staphylococcus Albus, Stephylococcus Citrus, Streptococcus Longus and Brevis, B. Proteus, B. Fluorescens, B. Fluorescens Convexus, Streptococcus Hemolyticus and Bacillus Pyocyaneus. Streptococcus Hemolyticus especially has given us considerable trouble, and has at times been the cause for rather widespread intestinal infection. I am personally of the opinion that the colon test alone should not be considered sufficient.

29. *Birdsall*—B. Welchii is not easily isolated from the group to which it belongs and has frequently been confused with the other members of the group.

30. *Graf* — B. Welchii has been frequently isolated from our filtered water, but no routine determination of its presence has been attempted because we do not feel that the results would be of much value. We have no evidence, from our experience, that would warrant a belief that B. Welchii is in any way responsible for any diarrheal or intestinal disorders that occur in people using city water. According to E. O. Jordan ("General Bacteriology," p. 344): "To its presence [referring now to B. Enteritidis Sporogenes. Editor] in milk, Klein attributes certain epidemics of diarrhea, but there is no sufficient evidence for this view, especially since Glynn has shown that large numbers of the bacilli may be swallowed by a healthy man without producing any immediate ill effect. Some writers have proposed that the presence of B. Welchii in water should be taken as evidence of sewage pollution, but the fact that the organism occurs abundantly in soil does not countenance the adoption of such a criterion.

33. *Rosenau*—I think B. Welchii in a drinking water has sanitary significance, but its effect upon health may be questioned. It is probable that B. Welchii, like B. Coli, in a drinking water is more an index than a menace. However, we are not sure of our ground, and therefore no definite statement can be made at this stage. The subject is a big one and should be studied from different angles in different parts of the country. It would be fine if a commission could be appointed to solve this puzzle.

38. *Hill*—The English bacteriologists have ascribed some importance to anerobic spore-forming bacilli as indicators of sewage pollution, of which the form described as B. Aerogenes Capsulatus (Welch and Nuttall, 1892), now called B. Welchii, and the form isolated by Klein (Klein, 1898 and 1899) in 1895 in the course of an epidemic of diarrhea in St. Bartholomew's Hospital, described under the name B. Enteritides Sporogenes (now called B. Sporogenes) are types, but some difference of opinion exists as to their pathogenicity. In America no great stress has been laid upon the presence of spore-forming bacteria in water supplies. In fact, qualitative bacterial examinations, although of great importance, have been attended with such difficulties that they have not been undertaken here to the extent that they have abroad. Spore-forming bacteria, however, are associated with sewage, as well as with intestinal disorders, and undoubtedly these bacilli have a much greater resistance to the application of chlorine than do the ordinary vegetative bacilli of the B. Typhosus type or the B. Coli type.

39. *Jackson* — Separate article, giving technique, will be published later on.

40. *Soper*—I should say that it was very scientific to use B. Welchii and B. Coli as a criterion by which to determine whether a water is fit for drinking purposes, but I do not think many authorities would place much reliance upon the test except where these organisms, one or both, were present in large numbers. And in such instances there ought to be other and confirmatory evidence. Sometimes it is impossible to get any but laboratory indications of a water impurity because it has laboratory significance only. Outside studies do not show that polluting material enters or that the water does harm. People should not be ordered to boil water unless there is actually ground for judging it to be dangerous. It may be a cautious thing to do, but it entails a great deal of trouble, and if it is not necessary people soon find it out, and come to look upon the health authorities as no authority at all.

43. *Ellms*—English bacteriologists regard the isolation of B. Welchii as of value but American bacteriologists seem to think it no more indicative than B. Coli. My confidence in public water supplies that have been chlorinated only has been shaken considerably of late. The B. Coli test does not seem to tell the whole story of pollution, and we may yet be forced to extend routine work for the isolation of bacilli found in polluted waters. I feel that chlorine may be quite unreliable as a disinfectant in some waters and is not of the same value at all times in the same water. Typhoid fever is rather heavily leaned upon in judging a public water supply, which is, of course, quite proper; but I believe that we must also give a great deal more weight to other intestinal troubles, especially gastro-intestinal troubles in infants.

44. *Perkins*—The literature shows that B. Welchii in water, like nitrates, indicates previous pollution. The spore-bearers do not develop under ordinary water conditions, nor are they affected to any marked extent by chlorination, so that tests will show them to be in treated waters which prior to treatment showed also aerobic fermenters. For this reason regular tests for these organisms are not made in most laboratories, especially as the detailed technic makes the labor excessive for the results obtainable. Broadly speaking, when in working out the presumptive into confirmed tests for B. Coli, no colon can be isolated and sub-cultures in fermentation tubes continue to show gas, anaerobic fermenters can be considered as present, among which B. Welchii is the most frequent. As far as diarrhea or other intestinal troubles from B. Welchii are concerned, it would seem on a priori reasoning that they should be no more likely than similar troubles from B. Coli, inasmuch as they are both intestinal organisms.

45. *Jordan*—The only direct experimentation on B. Welchii that I know about is the work Glynn published some twenty years ago (Thompson Yates Laboratory Reports, 1901, III, p. 131). This showed that large numbers of the bacilli could be swallowed by a healthy man without the production of any immediate illness. However, the study of anaerobes has developed greatly in recent years, and such experiments need repetition, with due attention to vertical differences. Herter and his collaborators are inclined to believe that the presence of B. Welchii in excessive numbers in the intestines was connected with the production of an anemic condition in children and adults. The use of the relative abundance of B. Welchii in water as an index of pollution may need further study but the widespread occurrence of this organism in soil does not seem to render it particularly suitable as an indicator of sewage of human origin.

nature, including soils and waters. It is a normal inhabitant of the intestines of both men and animals. It is a spore former, and therefore, like nitrates, an evidence of remote rather than recent pollution. Since it is a spore former, it may escape chlorination. B. Welchii—or perhaps a whole group, or it may be a number of strains, of lactose-splitting, spore-forming anaerobes—has been studied under ten or a dozen different names: Welch and Nuttall (Johns Hopkins University, 1892) giving the earliest full description as B. Aerogenes Capsulatus; Klein (Germany, 1895), using the name B. Enteritidis Sporogenes; various Englishmen, including Sir Alexander Houston using either the last preceding name or B. Sporogenes. These many terms and possible strains give rise to confusion, which, combined with difficulties in technique, cause doubt as to the past work and also as to the wisdom of making the test at present. Besides this, it may be inferred from the meager data at hand, that many of the tests reported as B. Welchii are merely presumptive. Some of those reporting think there is more cause for attributing non-typhoid intestinal outbreaks to milk than to water and it is pointed out that the extensive and growing use of milk pasteurization gives B. Welchii or related spores a comparatively free field in milk supplies.

Statements supplementing the tabular summary are presented as foot notes or, where too long, as text with reference numbers to the table. Even with the utmost condensation feasible some of the longer statements, and also data on the technique of B. Coli tests, have to be held for later issues. The longer summaries follow:

6. *W. F. Wells, Albany, N. Y.*—In the winter of 1910-11 while at Grand Forks, N. D., Dr. G. F. Ruediger and I isolated B. Welchii from river water treated with hypochlorite of lime. Whereas B. Coli was found in 0.1 c.c. quantities, before disinfection, B. Welchii was almost always found to be present in 5 c.c. quantities after disinfection. The change from a filtered to a disinfected water for several months did not seem to affect the health of the community in any way.

The Potomac River Investigation

During the investigation of the Potomac River watershed in 1914-15, I again had a chance to study the distribution of these organisms, while serving under Surgeon (now Surgeon-General) Hugh S. Cummings, U. S. Public Health Service. It had been noticed in the areas of high sewage pollution where B. Coli was present in large numbers that little difficulty in the isolation by ordinary methods was experienced. As B. Coli decreased, however, the percentage of gas forming organisms which proved not to be B. Coli, also diminished. It suggested a similar phenomenon to that of Grand Forks, N. D., except that the death of B. Coli was due to natural causes instead of artificial disinfection. Following out this clue I made a rather extensive survey of the Potomac River to determine the natural distribution of these organisms in a typical river. (See pp. 97-105, "Investigation of the Pollution and Sanitary Conditions of the Potomac Watershed," Hygienic Laboratory Bulletin 104, U. S. P. H. S., Washington, D. C., 1916). It was shown that the gas forming anaerobes are generally distributed throughout the whole region in small numbers, and because they do not die off as rapidly as B. Coli they persist even after B. Coli have disappeared. In other words, they seem to be rather generally distributed in a polluted river in small numbers, without great variation in number as compared to B. Coli.

Furthermore, the studies at Fishermen's Island, Va., in areas remote from sewage pollution, revealed the presence of these organisms in small numbers in sea water and in fairly large numbers in the mud areas. It seems likely that wherever organic matter is undergoing putrefaction the organisms flourish. Tests made on the rapidly fermenting sediment in the Chesapeake and Ohio Canal at Cumberland, Md., show the presence of 500,000 spores per cubic centimeter.

Houston, in England, has done much work on the distribution of this organism in river water and has accurately described the same phenomenon. Savage, in summarizing large numbers of results by different workers, shows the general distribution. They are found commonly in milk and various foodstuffs. The common infection of wounds in trench warfare of the Great War also indicates general distribution in soils. Dr. Creel of the U. S. Public Health Service found a large percentage of treated waters on trains to contain this organism in small numbers. In the International Joint Commission report its occurrence in large numbers in the St. Johns River is also noted.

Broad Classification Better Than Fine Distinction

Until more definite methods for classifying the B. Welchii group of organisms are developed it seems better for the impartial water-works operator to make a broad classification and not attempt to go into finer distinctions. Until some particular member of the group is discovered to have a pathogenic effect when taken in small numbers in drinking water it is only logical to assume that the wide distribution of the general group, and its common occurrence in drinking waters without any distinct result having been observed, makes its presence no cause for alarm. Unquestionably, if some of these organisms become lodged in a portion of the body which will permit the development of anaerobic organisms, they may cause a very serious condition. Ordinarily, therefore, it seems probable that the organism may be taken in small numbers in drinking water without serious danger. Furthermore, its significance is an indication of the sanitary condition of water entirely different from that of B. Coli, and its presence cannot be accepted as an indication of a dangerous water supply.

15a. *H. P. Ferguson and M. W. Cowles, Springfield, Ill.*—For the past year we have been making examinations at regular intervals of filtered and sterilized water from several Illinois plants. Many of the samples of filtered water, with or without sterilization, especially where the raw water was rather highly polluted, showed a considerable number of gas formers on presumptive tests, but confirmatory tests on endo medium failed to produce any growth whatever in many of the samples. In some supplies it was possible to have the dose of chlorine increased, but the percentage of gas formers was not substantially reduced.

At Quincy, where daily control tests on Mississippi River water, filtered and then sterilized by liquid chlorine, were carried on by Mr. Gelston, superintendent of water-works, the number of gas formers present on presumptive tests increased considerably in 1920. An increased dose of chlorine failed to reduce the number of tubes showing gas formation. On account of lack of sufficient personnel we could send no one to Quincy to make daily tests for B. Welchii or other organisms of the same group but a few samples sent to our laboratory at Springfield were inoculated into litmus milk, in anaerobic culture, and organisms of the B. Welchii group were found present. In about a month the amount of gas present in presumptive tests began to diminish suddenly and special tests failed to show the presence of B. Welchii in large numbers, even in the raw water. From the local records it appears probable that these organisms will not again appear in the raw water until the fall of 1921, when it is hoped that a more complete investigation may be made.

The presence of these organisms has also been suspected in water obtained from Rock Island, Alton and at times from East St. Louis. At Rock Island and at Alton the sterilizing agent is added to the raw water and it could be expected that an increase in the amount of chlorine would produce a smaller effect on the resulting effluent than if the sterilizing agent were added after filtration. The filter plants at the four cities mentioned have to treat water polluted by sewage, in some cases from communities many miles up stream, and in other cases by relatively fresh

sewage. It is hoped that as soon as sufficient personnel is available that detailed field investigation may be carried on in these four cities and at filtration plants where similar conditions exist.

The literature indicates that B. Aerogenes (as distinguished from B. Coli), B. Aerogenes Capsulatus, B. Enteriditis Sporogenes, and B. Welchii are so nearly alike that only complete morphological and cultural tests will distinguish between them, and that the organisms may be found in sewage in varying quantities. From the results obtained in confirmatory tests made in this laboratory on endo medium and on eosin methylene blue agar, it appears possible the aerogenes colonies, as distinguished by Levine, may at times represent a very resistant group of organisms which are possibly directly and closely related to the spore-forming organisms of the B. Welchii group but considerable detailed laboratory investigation will be necessary to determine if this relationship exists.

At this time, no definite information can be given relative to the harmful effect or disease producing power of the spore-forming organisms of this type when present in a water used for drinking.

16. *J. J. Hinman, Jr., Iowa City, Iowa.*—Material I collected in 1917 for my paper on American Water Works Laboratories (*Journal* Am. W. W. Asso., June, 1918) shows no reference to any one making a routine search for the Clostridium Welchii, and I do not know of any laboratory at the present time that regularly makes this examination. Recently in checking up the results with fermentation tubes from 15 Iowa water supplies filtered and chlorinated (no reports of intestinal trouble from any of the corresponding communities) I found the following distribution:

Tubes showing B. Coli type	391
Tubes showing B. Aerogenes type*	85
Tubes showing atypical gas formers†	1,902
Tubes failing to show gas formations	8,188
	10,566

*During a part of the series B. Aerogenes was not differentiated from B. Coli.

†Most of the atypical forms refused to grow aerobically on the confirmatory plates. They appear to have been commonly spore-forming anaerobes.

Lately I have tried a modified Weinzirl anaerobic spore-former test, using a dried milk medium and planting in it either 10 c.c. of the water or a few drops of the liquid from positive fermentation tubes. For all practical purposes this test is the same as the Botkin test for Clostridium Welchii. In a number of tubes I obtained gas production, stormy fermentation, and butyric acid odor. I did not carry the work further.

Welchii Trouble from Milk Rather Than Water

The Clostridium Welchii is so frequently found in milk that if there were any great danger of intestinal infection due to its presence in the normal human intestine, we could expect continual trouble from the milk supply, rather than from the purified water supplies, where the concentration is certainly much less than in milk supplies. The work of Kendall and others indicates that Clostridium Welchii, chiefly from cow's milk, in all probability, has caused diarrhea in young children. Kendall and Day claim that two factors are necessary to the multiplication of the organism in the intestines: (1) excess of utilizable carbohydrates, and (2) deficiency in lactic acid forming organisms, since the production of the acid tends to inhibit the growth of the Clostridium Welchii. The diarrhea has been ascribed to the irritant action of butyric acid formed by the Clostridium. Perhaps a soluble toxin is also involved.

If it is believed that these occasional difficulties, probably due to milk-borne infections, are sufficient ground for demanding that public water supplies shall be free from these organisms after purification, an enormously heavy burden will be put upon the plant. The different strains of the Clostridium Welchii react somewhat differently to heat. Heating to above 80 deg. C., or even to boiling, cannot be expected to kill 100 per cent of the spores, nor can chlorine in practical concentration remove all of them. Greatly improved filtration practice would seem to be the only way of removing all these spores.

When polluted water has been treated, finding in the effluent an organism known to be much more resistant than the ordinary pathogens can have little value as indicating sewage contamination. Unless it is necessary to exclude the Clostridium Welchii for its own pathogenic properties, a more useful search is the examination for the B. Coli type organisms, imperfect though our knowledge of this group may be.

New York City Gave Up Routine B. Welchii Tests

20. *F. E. Hale, New York City.*—When D. D. Jackson first devised the use of lactose bile for the presumptive test for B. Coli, we knew that B. Welchii also gave this test and believed it to be the only form in addition to the B. Coli group which produced gas to any extent in that media. We had accessible the original article by Dr. W. H. Welch, Johns Hopkins University, and obtained cultures from him which we compared with cultures of Sporgenes (so-called) obtained from Klein in London. The latter culture proved to be the same as that furnished by Welch, but later work indicated that there was an entirely different form which we isolated from water and which could be classed under the name Sporogenes and did not ferment lactose. We had also available Klein's original literature.

As B. Welchii is always present in small amounts in feces of human beings and animals, Jackson felt that the fact that B. Coli gave this test in presumptive media did not detract from the B. Coli test, since either was of equal significance. As it was easy to isolate B. Welchii, in case one cared to, from the bile tube we frequently did so. It was only necessary to make a hanging drop when long chains of large bacteria, non-motile, were visible, and usually a plate made from a tube in which Welchii was present and incubated at 37 deg. C. would prove sterile, Welchii overgrowing the other forms in the bile and not appearing on the plate, as it was anaerobic. Different workers have found that B. Welchii interfered with the study of efficiency of chlorination plants, owing to the spores not being killed by chlorination. Since these spores might exist in the soil or elsewhere for a year or more, it was felt that their presence did not signify recent contamination and consequently arose the change in Standard Methods (which I personally considered a step backward) by the dropping of bile and the use of the lactose broth with confirmation of the B. Coli group (and since then it has been recommended to differentiate the fecal from so-called non-fecal forms of B. Coli in order to narrow down the evidence).

I think the work involved was too great for the value received in these various isolations *as routine* and have given more attention to the tests for B. Typhi, etc. Owing to the trend of opinion against B. Welchii as of any significance a new media has been developed at this laboratory and used for nearly two years past—a modification of the lactose peptone bile by the addition of brilliant green, which eliminates B. Welchii from the presumptive test.

The following table showed the relative number of tests for specific bacteria which we made during the last four years:

	1917	1918	1919	1920
Bacteria, (total count 37° C.)	10,673	11,518	13,377	13,349
B. Coli (presumptive)	10,724	11,537	13,377	13,357
B. Typhi	809	1,325	708	728
B. Sporogenes	361	860	296	150
B. Welchii	1,255	238	72	...

From April 1, 1917, to April 1, 1918, the presumptive test for B. Coli was confirmed and identification of B. Welchii made with the result that out of 5,283 samples examined B. Coli was positive in 1,493 samples and B. Welchii was present in only 1 per cent of the total samples. It also indicated that 4 per cent of the presumptive B. Coli tests contained B. Welchii, or vice versa, that 96 per cent of our presumptive tests were certainly B. Coli.

We have found B. Welchii in ice in the absence of B. Coli and the intestines of sea-gulls exposed dead to very cold weather to the exclusion of B. Coli. Samples of water containing B. Welchii when tested for several days in succession have very soon shown the disappearance of Welchii, indicating that the spores may develop in water supply and die out, and that Welchii does not form spores in water.

23. *W. C. U. Baton, Pittsburgh, Pa.*—I have made some studies of B. Welchii but never arrived at a point where I placed any practical value on the results obtained. In 1911-12 we made quite an exhaustive study of the presumptive test for the colon group. (See 1912 report of the Bureau of Water, Pittsburgh.) We ran into an anaerobic gas-forming bacillus which caused a disturbance in the smoothness of the presumptive colon test. This organism we called the "gas bacillus" because we were unable to make it check up satisfactorily with our conception of B. Welchii; it was probably closely allied to that organism. We were unable to devise a means of absolutely eliminating or including it in the presumptive test. It did not appear with regularity. As nearly as we could determine, it seemed to appear more frequently during periods of low than high temperatures of the water. It will appear in any presumptive test, but is eliminated from confirmed colon tests because it will not develop on the isolation plate. About this time the 1912 edition of Standard Methods, A. P. H. A., outlined the test for B. Sporogenes. We made considerable trial of this test to see if it appeared to have any practical value locally. As I remember it, we were able to get an occasional isolation, but the test did not promise to be useful in routine work and was discontinued.

It is my opinion that B. Welchii or B. Aerogenes Capsulatus as well as B. Sporogenes (sometimes named B. Enteritidis Sporogenes) and the organism above referred to as the "gas bacillus" are all closely allied.

See No Substitute Yet for Colon Test

As yet I have seen no method of getting away from the colon test, but I believe it can be greatly improved in value by careful confirmation and by determination of the main species of the group. Some four or five years ago we did considerable work on the Colon-Aerogenes group, as found in fecal matter and other sources. As time permits, we are still working on improved methods of separating the Aerogenes from Coli in routine tests. We believe we are able to make better interpretations of results than formerly.

I believe the time is not far distant when interpretation of bacterial water analyses is going to be on a very firm foundation and the experienced man is going to be able to classify the sanitary quality of waters within quite narrow limits. When this is done we shall probably find ourselves cut loose from arbitrary standards and rule-of-thumb methods.

I have no personal evidence that B. Welchii causes waterborne diarrhea. I can conceive from the nature of the organism that in numbers it might cause considerable disturbance in the intestinal tract.

26. *H. E. Jordan, Indianapolis.*—We have found from time to time in the chlorinated filtered water, during the cold months, organisms (named by us F-11-21) which produce initial fermentation in lactose broth, are not recoverable on the ordinary sub-culture plates and require a commensal to bring their various reactions.

During the winter of 1919-20, Indianapolis, and a good many other cities in this part of the country, had a considerable amount of infection which, according to the views of some physicians, manifested itself in certain cases in the respiratory tract and in other cases in the intestinal tract. The winter of 1920-21 was relatively free of both types of infection.

Available literature indicates that those who studied B. Welchii and possibly identical or related organisms in the earlier days found it associated with soil pollution. Studies of intestinal outbreaks, I believe, can nearly always be correlated with irregularities of filter operation or mishaps to distribution systems which would be shown if the volume of work done in the control laboratory was large enough to make it deserve the term "control."

In my recent paper on "Fifteen Years' Filtration Practice in Indianapolis" there is an extensive series of tabulations of B. Coli counts. The figures were presented to convey to those interested in this kind of work some idea of the feeling that I have that we should not deny the presence of fecal organisms in purified water supplies. It is not a question of the presence but of the concentration of fecal organism that is significant. I have repeatedly suggested in conversation that in bringing a purified water from surface sources as long as the supply receives pollution from intestinal disorders, we must take it for granted that it is only a question of drinking a large enough quantity of water until the individual takes in organisms associated with every type of such disorders. It is only when the mass action of a large group of fresh individuals having intestinal disorders occurs that we have the transmission of the troubles to uninfected individuals.

Possible Test Methods

I have very little doubt that the inhabitants of every city that uses a purified water drink B. Welchii in greater or less numbers every day. The question is whether or not these organisms are virulent and whether their concentration is great enough to produce sickness. With this in mind we have been giving much thought to methods that might be followed to make a fairly accurate numerical estimation of the kinds of organisms present, doing this by the dilution method. The fundamental in this would be the elimination of non-spore forming organisms. Whether these should be eliminated from the raw water by chlorination or heat sterilization is a question. Another procedure would be to inoculate various tubes of plain peptone broth with dilutions from the original sample—this broth, according to the concensus of opinion found in textbooks on bacteriology, being the medium in which B. Welchii is more likely to form spores. After an opportunity has been given to spore-forming organisms to reproduce themselves, then the medium could be subjected to partial sterilization and the procedure of the deep endo plate and milk tubes carried on. I believe that it is a comparatively simple matter for non-spore forming organisms that have a tendency to overgrow to be eliminated.

We are going to try the matter out in our laboratory, but it will probably be a year or two before we make up our minds as to the best procedure in order to take in at least one season's variations in bacterial flora.

[*To be continued June 9, with statements by N. J. Howard, S. C. Prescott, M. J. Rossman and others listed with reference numbers in group 3 of the table,* p. 929.—Editor.]

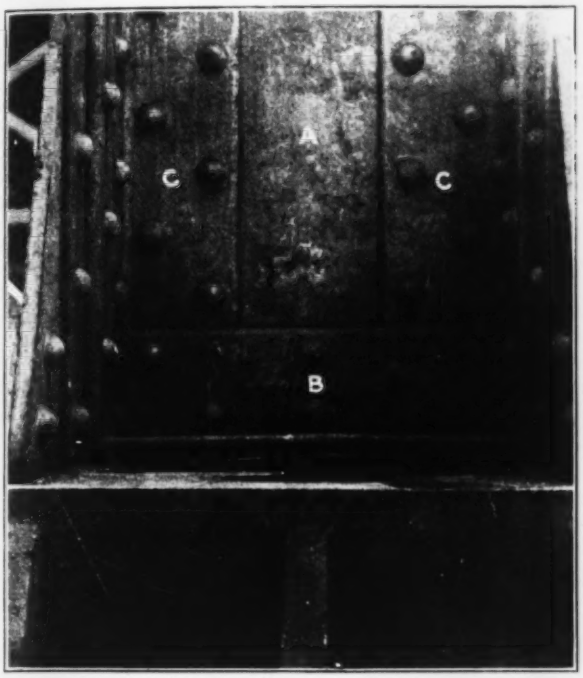
Montreal Retains Mayor-and-Council Charter

By a majority of some 17,000 in a vote of 68,000 out of 147,000 possible votes, the electors of Montreal on May 16 voted for a mayor-and-council city charter, with (1) an executive committee of five councilmen, chosen by the council, and (2) a director of municipal services, also appointed by the council, with such duties as the council may assign to him from time to time. The councilmen will be elected by plurality vote, one each from 35 wards. The defeated alternative charter provided for a council-manager plan, the council to consist of 15 members chosen by proportional representation, five each from three districts, and the general manager to be appointed by the council. Under the plan adopted the mayor will be paid $10,000 a year and councilmen $1,500, with extra pay of $1,500 for the chairman and $1,000 for the members of the executive committee. The rejected plan was drawn by a charter commission appointed by the Provincial Government and the adopted plan was the work of local members of the Provincial Legislature. For some two years Montreal has been governed, in most respects, by an Administrative Board, appointed by the Provincial Government, the old mayor and council remaining in office, but having little power. The new charter will go into effect Nov. 1. The alternative plans are outlined in parallel columns in the *Canadian Municipal Journal* for April.

Freezing Action of Water Distorts Steel Column and Base

By C. P. Bohland
St. Paul, Minn.

THE accompanying photograph, indicating the tremendous force which may be exerted by the freezing action of water upon structural steel and cast-iron members, is of a cast-iron base supporting a structural steel column recently erected at St. Paul, Minn.



DISTORTION OF STRUCTURAL MEMBERS DUE TO FREEZING OF WATER IN CAST-IRON BASE

On March 28 steel and cast-iron members were exposed to a heavy downpour of rain which was accompanied by a driving wind. On the following day the temperature dropped rapidly and by the morning of March 29 had reached zero. The rain, being driven against the steel column ran down the column web *A*, and on down between the ends of the filler plate (between the angle *B* and the web *A*) and the angle *C*. As the oval opening in the top of the cast-iron base lay directly under this flow of water and under the outstanding leg of angle *B* the cell in the cast-iron base became filled with water.

As the water froze the top of the cast-iron base was sheared along the inner web and was also deflected upward, bending the horizontal leg of the angle *B* upward a distance of 1¼ in. An inspection revealed that no injury had been done to the web nor had the top of the cast-iron base been distorted where the column web and the flanges took bearing.

Author of Log Flume Article

In the article on log flume construction in *Engineering News-Record*, May 5, 1921, p. 768, the author, V. K. Woods, was given as a member of the firm of Palmer, Pearson & Woods, Salt Crescent, Wash. This is an error. Mr. Woods is no longer a member of the firm. He is now located at Cranbrook, B. C., Canada.

Traffic Problems of the State Highway Department

Statement of Main Factors Which Should Determine Economic Development of Highway Systems

By Charles J. Bennett
State Highway Commissioner of Connecticut

Paper presented May 23 at the Conference on Highway Traffic Regulation held under the auspices of Yale University, New Haven, Conn.

THE past ten years have seen a complete transformation in the problem confronting administrative officials in the state highway departments. In the early days of highway development indications pointed to a simple problem. Traffic was not a serious factor and was not considered extensively in the location and design of highway systems. The lack of vision shown in this approach to a tremendous activity was lamentable. At that time the administrative officer was generally a man who knew how to lay out highways simply with a view to improve their general condition satisfactory to local interests and to the accommodation of light vehicles. The result is that the state highway systems of those states which have participated for a longer time in the improvement of highways have been improved to an inferior degree of excellence and are not satisfactory to the traffic which is developing.

For this reason the highway administrative engineer at the present time should have become a student of transportation rather than of detail highway construction. In other words, traffic has become the most important factor in the administration of public funds used for the development of highway systems. The highway engineer should be interested, furthermore, not only in transportation as it affects highways but in all classes of transportation in order that he may determine to what extent and for what facilities the highway program should be developed.

Over-Development of Vehicle

No one at the present time has any proper or correct conception of the place in the transportation scheme which the highway must fill. Due to several contributing causes, the development of highway transportation has proceeded along abnormal lines. There has been, naturally, a tendency to over-develop highway transportation. This over-development has been in the vehicle, generally, at the expense and to the detriment of the road. There has been a very consequent slacking off in the development of railroad facilities, due partly to the over-development of the motor vehicle as well as to the lack of funds and material used in the enlarging of railroad activity.

We have had a very serious reduction in the rail transportation of passengers and freight. Some of this decrease is due to the proper development of the motor vehicle and some of it to an abnormal or unusual use. In the near future we must come to realize the proper place for each method of transportation in the general scheme, and, as stated above, the highway engineer is vitally interested in this problem. If we know to what type of traffic the highway is to be subjected, our problem is somewhat simplified.

For purposes of discussion, let us, therefore, dissect this subject, assume certain things regarding the traffic problem of the state highway departments and discuss facts or suggestions which may come from the division. Traffic may be divided roughly into two classes: (1) commercial traffic, including the motor truck; and (2) passenger or pleasure traffic, which includes all motor vehicles using the highway for carrying passengers. With slight exception, it may be stated that the class of highway suitable for the carrying of commercial traffic will be adequate for the use of passenger vehicles. Our study of the commercial vehicle and its use and the suitable highway for this agency must, therefore, be the more careful.

In order properly to outline this problem we must know definitely several things about commercial traffic. It is evident that the motor truck has a proper place in the scheme of transportation and must be operated, to be economical,

within certain limits. Figures show conclusively that, under the present cost of operation of motor trucks, the maximum limit for the economic operation of motor trucks is approximately 125 miles. At this point, under present conditions and with freight rates as they exist, the cost of transportation by motor truck begins to exceed the cost of transportation by rail. Consequently, here is one definite limit, under present conditions, for the operation of the motor truck. As conditions change, however, this particular limit may be lowered or raised. For instance, if we increase materially the license fee on motor trucks, the economic limit of operation will be reduced. Conversely, if freight rates decline, the economic short haul limit for rail will be reduced. Connecticut, which lies midway between Boston and New York, is almost entirely within the above-mentioned economic truck operation distance from both New York and Boston. This is interesting and an indication of the condition which materially affects our railways in their transportation of local freight.

Service Rendered as Basis for License Fees

An analysis of the daily cost of truck operation shows that out of a total operating cost of $26.09, 11c. is spent for the license fee, or for that portion of the operating expense which pays for the use of the road. From the standpoint of road service it has been found by certain experiments that the operating cost per mile on a hard, smooth pavement is approximately one-half of the cost on an ordinary earth road. If the direct operating cost for the above-mentioned truck, including the cost of gasoline, oil and tires, is taken into consideration, the cost for these items is approximately $6 a day. If one-half of this sum is saved by road improvement, a daily saving of $3 will be made which, reduced into yearly license, would allow a maximum license, based on the saving in operation during 250 working days per year, of $750 as against (with the 11c.-a-day fee) $27.50. These figures throw a new light on this phase of the problem.

The problem of Connecticut, of course, is not the problem of Iowa or California. We have no immense distances. We are not developed agriculturally to any extent. The development of our highway system for the two classes of traffic mentioned above demands a return from the traffic using the road, because there is but slight local benefit accruing to abutting property owners. This, then, is the traffic problem of Connecticut, so far as the highway department is concerned.

We are concerned only incidentally with safety of traffic. This is the responsibility of the motor vehicle department. Our general concern is with the development of our highway system in order to accommodate the commercial and passenger traffic and to develop this system by means of the funds secured from the agency which uses the highways—the motor vehicle. We are not prepared to say just what proportion will ultimately be paid by each type of vehicle. We hope to establish a definite relation between the commercial vehicle and the passenger car. We must not attempt to secure from the passenger car an amount in excess of the cost of service rendered. We should not, in the case of the commercial vehicle, subsidize it at the expense of the state and to the detriment of the railroad. We must endeavor to find out the proper place for each type of transportation so that we may be sound in our conclusions.

We know that the motor truck has come to stay. We realize that Connecticut is one of the most advantageous fields for its development. We consider it no more than fair to collect from the commercial vehicle a sufficient amount of money to provide for the extra service rendered by the highway to this agency. This is the traffic problem of the state highway department so far as it concerns that department itself. The width of highway, the type of highway and the ruling grade are merely incidents which can be properly related to the economic vehicle limit when the same is found. I do not attempt to solve this problem, but merely to state it, and even then in only a nebulous manner.

The future holds a great many problems. Before these may be solved they must be expressed in definite form. To secure definite factors to include in these different equations information must be secured. We have a two-fold problem: We must find the volume of traffic which may ultimately use the highways to be developed and we must also construct a type of highway for the accommodation of this traffic which is satisfactory and suitable. Information at hand is meagre. The effects of different types of traffic on different types of road surface must be secured. The volume of traffic must be taken at different seasons in the year at different points and a forecast of the ultimate traffic made therefrom. Studies of impact stresses and innumerable things suggesting themselves from the general situation must be made.

It will be interesting here to inject a statement as to the volume of traffic using the roads of this state on a particular three-day period. Early in May, for 72 hours, the total number of vehicles counted at 56 points in the State of Connecticut was 240,900. These were divided into 204,300 passenger cars and 36,500 trucks. This information is simply preliminary. The volume at particular points is intense; at other points, the volume is light. Collecting these data and drawing inferences from them, we should be able eventually to find the proper solution of the highway construction problem from the traffic standpoint and determine the types of highways to be constructed at different points.

When it comes to the relation between amount of traffic and the cost of highway repair we have another factor. It may be shown that eventually certain highways will need certain types of pavements from the forecast made by the cost of maintenance under certain volumes of traffic and by the volume of traffic which may be determined as eventually using this road. The problem is complicated. The underlying principle which should be stressed is that, in order properly to develop our traffic, we must secure from that traffic a sufficient payment in license fees to pay for the service rendered. Much has been said regarding the advisability of taxing a particular agency for the upkeep of roads. When it is thoroughly understood, however, that the roads are built for the automobile and without particular regard to any other type of traffic, it seems fair to lay the burden of the cost of financing these improvements on this agency, which is the most benefited.

Research Bureau Essential

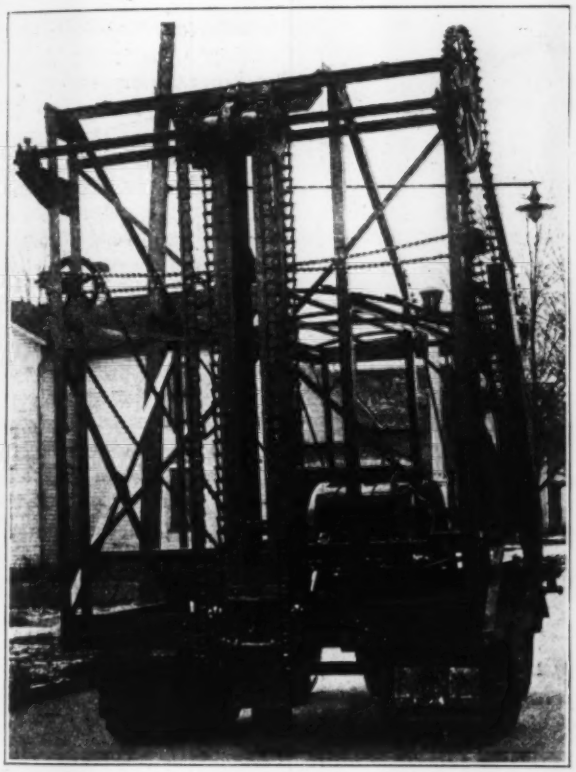
What is needed more than any other information is a thorough understanding of the relation between traffic and the highway, and it seems imperative that means for securing this information be established. A bureau of research is needed. This bureau should investigate the detail relations between traffic and highway, and should not stop at this particular point, but should extend its work to a thorough investigation of the transportation problem from all standpoints, including all means of freight and passenger transportation, having in mind the development of waterway, railway, trolley, highway and possibly the air. It is a big job and of vital importance to the welfare of the country. The sums of money spent in highway improvements are tremendous. The effect of this expenditure on the public is manifold. Money spent on one agency cannot be spent on the other. Unnecessary work done in highway development will mean curtailment of expenditure in other sources, particularly for other means of transportation. The problem should be stated in simple terms and solved in the interests of the general public.

Board of Estimate and Control for New York State

A State Board of Estimate and Control has been created for New York by an act passed by the Legislature and approved by the Governor. The board will consist of the Governor as chairman, the state controller and the chairman of the Senate and Assembly Finance Committees. Besides preparing an executive budget, the board is directed by the act to consider the administrative departments of the state for the purpose of increasing efficiency and economy in state matters.

Pavement Breaker for Starting Water-Works Trenches

FOR cutting trenches through pavements a machine resembling a small mounted pile driver has been developed in Detroit by the engineering department of the Board of Water Commissioners. In pipe extension work, of which no less than 141 miles was done during 1920, frequent cuts have to be made through 6 and 10-in. concrete pavement base. The concrete breaker, which



DETROIT CONCRETE AND PAVEMENT BREAKER

is shown in the accompanying views, is expected to prove a great labor-saver in this work.

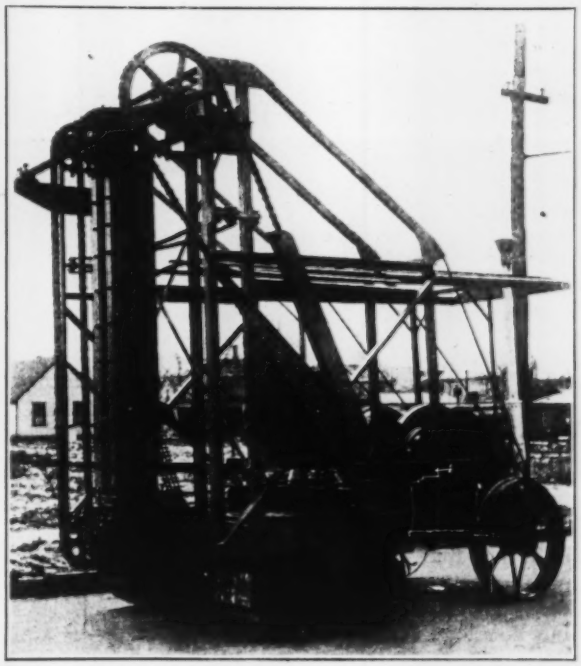
The machine is carried on two short crawler tractors and two wheels. On the forward end of the frame is a gasoline engine, and on the rear end is an automatic hammer. The chisel or cutting edge of the hammer is shown set crosswise of the machine, but in practice the edge is generally turned parallel to the trench. The hammer leads can be moved transversely while the hammer is being raised. The machine is built to break a surface 6 ft. wide; wider openings require several trips.

With over-all dimensions 9 x 15 ft. x 14 ft. 2-in. height, the concrete breaker weighs 14,000 lb. Its wheel base is 6 ft. 9 in. The traction base has 21 x 10-in. tread plates. The hammer, weighing 1,225 lb., has a removable bit 14 in. long by 9 in. wide with a 90 deg. beveled cutting edge which may be placed lengthwise or crosswise of the hammer. The bit is a steel casting, 0.40 to 0.50 per cent carbon, casehardened to prolong its life.

The hammer has a hoisting speed of 76 ft. per min., strikes 14 blows per min., and has a crosswise travel of 6 ft. at the rate of 35 ft. per min., which permits a shift of 1¾ ft. between blows. It is picked up by three tiltable spurs on the hoisting chain; these spurs are held out to engage lifting lugs on the hammer by an angle-iron track bolted to the leads, and trip automatically at the upper end of this track. The track is in removable sections 10 in. long, which permits increasing or decreasing the drop of the hammer. The maximum drop of the hammer is 7 ft. The cross-travel of the leads is controlled by a friction clutch. The hammer may be held suspended by a ratchet on the hoist shaft, which permits the machine to be moved about from job to job. The road speed is approximately one mile per hour and the breaking speed approximately 15 in. per minute. The engine is 8¼ x 12 in., developing 15 hp. at 350 r.p.m.

During the past winter two of the machines have been used to break frozen ground in unpaved streets. Up to April they had been used more for this purpose than to break pavements. Experience indicates that they will break 500 ft. of clay frozen to a depth of 18-in. for a trench 6 ft. in width in an 8-hr. day, and about the same length of 8-in. concrete pavement. They work well on any pavement, but better on asphalt when the surface is cold and hard. In hot weather, when the asphalt is softened, it tends to stick to the cutter.

One operator with a laborer following handles the machine. The gasoline consumption is 1¼ gal. per hour,



SIDE VIEW OF BREAKER, HAMMER LIFTED

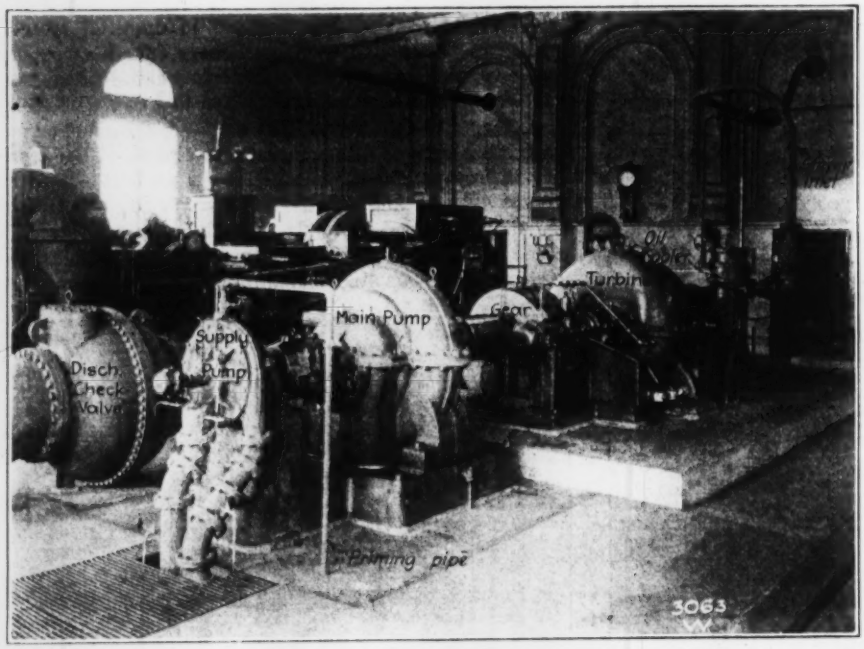
and 1 qt. lubricating oil is consumed per day. At the close of the 1920 season the operator was paid $1.04 per hour, but later the wage was reduced to 90c. Cost records are not yet available.

While the design of the machines is new, the principle on which they operate has been tried out by the department for more than a year. The original machine require the operator to raise the hammer each time a blow was struck, and it was not possible to shift the hammers sidewise. The old machine is still in use, has been fitted out with rubber-tired wheels, and is towed by truck to various parts of the city to handle small jobs.

George H. Fenkell, superintendent and general manager, Board of Water Commissioners, states that Henry Cousino, engineer of power machinery, is largely responsible for the design of the breakers.

Baltimore Pump Sets New Duty Record for Centrifugals

A NEW duty record for centrifugal pumping engines has been established by a 30 m.g.d. unit in the Mt. Royal Station of the water-works of Baltimore, Md. The official tests showed a maximum duty of 170,250,000 ft.-lb. per 1,000 lb. of steam at 175 lb. gage pressure, 60° superheat and a water temperature of 70° F. The Baltimore unit comprises a 30 m.g.d. single-stage centrifugal pump with 30-in. inlet, 24-in. outlet and 36½-in. impeller driven by a 1275-hp. Curtis type steam turbine through reduction gears in solid bearings. The turbine exhausts to a waterworks condenser with 4,000 sq.ft. cooling surface. On the end of the pump shaft is a special design of 5-in. supply pump for the condenser air pump—which is an "eductor" type. The air pump is operated, at starting, from a connection to the suction main of the unit, this being under about 40 lb. pressure. Condensate is drawn from the condenser hotwell by a two-stage 2-in. 1360-r.p.m. pump driven by a 3½-hp. Pelton wheel. The condensate and the discharge of the hydraulic auxiliaries is received in a vented sump. The turbine weighs 31,000 lb. and the pump and bed plate 26,000 lb.

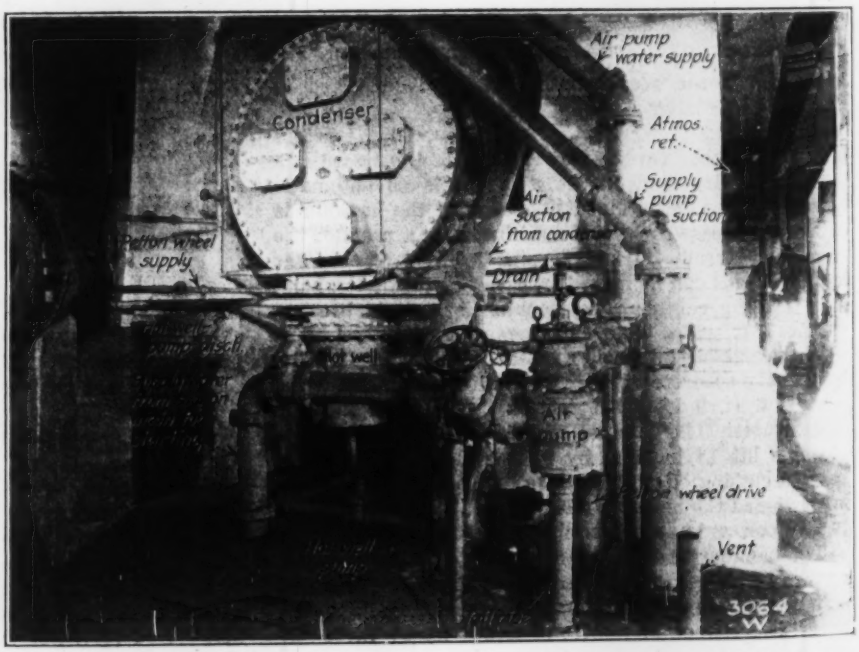


THIRTY MILLION-GALLON CENTRIFUGAL PUMPING UNIT, MT. ROYAL STATION, BALTIMORE

The contractor for the complete unit was the Worthington Pump & Machinery Corporation, Harrison, N. J. The pump and condenser equipment were built at the Worthington works, and the turbine was built at the Lynn works of the General Electric Co.

The accompanying table shows the official test results of the City of Baltimore. The head and duty results have been plotted in the accompanying curves. The tests were made jointly by the city and contractor under the direction of F. Howard Cronin, superintendent Mechanical Division Baltimore Water Department, and Robert W. Allerton, superintendent Erecting Department of the Worthington Corporation.

In making these tests the condensate was caught and weighed. Suction and discharge quantities were measured by a pitometer. Steam pressure was read from a calibrated gage at the main throttle and temperature was taken by thermometer in a well at the same point. Vacuum pressure was measured by mercury column attached close to the turbine and exhaust temperature by a thermometer in a well close to the condenser. Temperature of the inlet water was measured near the condenser. The suction water pressure was measured by calibrated gage near the condenser inlet, and discharge pressure was taken close to the pump discharge outlet. Velocities of flow were computed.

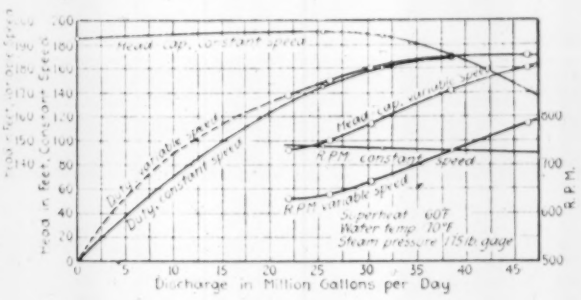


CONDENSER AND AUXILIARIES OF MT. ROYAL CENTRIFUGAL PUMPING UNIT

OFFICIAL TEST DATA AND RESULTS OF 30,000,000 GAL. CENTRIFUGAL PUMP AT MT. ROYAL PUMPING STATION, BALTIMORE, MD.

1	No. of test		1	2	3	4	5	6	7
2	Date	August, 1920	4	4	4	6	6	6	6
3	Duration	Hrs.	2	4	2	1	1	1	1
4	Atmosphere pressure (elev. 111 ft. Baltimore datum)	In. hg. 32° F.	30.12	30.07	30.06	30.06	30.04	30.00	29.98
5	Temperature of room	Deg. F.	83.4	86.84	85.57	84.14	88.2	88.8	88.28
6	Throttle steam pressure gage	Lb. per sq.in.	174.7c	174.3	172.9	172.3	174.4	173.4	172.6
7	Throttle steam pressure absolute	Lb. per sq.in.	189.54	189.06	187.65	187.05	189.15	188.00	187.22
8	First stage steam pressure gage	Lb. per sq.in.	28.2	81.07	88.9	114.1	57	50.5	46.66
9	First stage steam pressure, absolute	Lb. per sq.in.	42.98	95.8	103.7	125.4	71.8	65.25	61.4
10	Temperature of throttle steam	Deg. F.	412.4	420.8	426.48	429.3	413.1	409.9	403.6
11	Degrees superheat of throttle steam	Deg. F.	55.0	45.6	49.42	52.98	35.84	33.2	27.21
12	Vacuum exhaust outlet of turbine	In. hg. corrected	28.956	28.937	28.94	28.955	28.974	28.962	28.944
13	Vacuum exhaust outlet of turbine	Lb. per sq.in.	14.217	14.208	14.21	14.22	14.226	14.221	14.211
14	Back pressure absolute	Lb. per sq.in.	0.572	0.556	0.549	0.539	0.523	0.509	0.509
15	Temperature corresponding to vacuum	Deg. F.	85.8	82.99	82.54	82.0	81.06	80.2	80.2
16	Temperature of exhaust, actual	Deg. F.	80.9	81.0	80.0	80.0	78.0	78.0	78.0
17	Temperature of condensate	Deg. F.	78.7	78.88	78.07	74.4	74.98	75.77	76.76
18	Wt. of condensate from turbine, including leakage	Lb. per hr.	12,011.5	13,087.7	13,859.5	17,282	10,484	9,265	8,250
19	Wt. of condenser leakage	Lb. per hr.							
20	Condensate chargeable to turbine	Lb. per hr.	12,011.5	13,087.7	13,859.5	17,282	10,484	9,265	8,250
21	Suction pressure, inlet to condenser	Lb. per sq.in.	40.86	39.72	38.72	37.12	37.918	38.88	39.12
22	Suction pressure, inlet to condenser, including vel. head	Lb. per sq.in.	46.21	45.41	44.23	43.40	45.94	46.47	47.34
23	Discharge pressure at nozzle	Lb. per sq.in.	121.82	118.869	110.12	111.78	104.16	102.37	101.58
24	Discharge pressure at nozzle, including vel. head	Lb. per sq.in.	122.36	121.19					
25	Distance between suction and discharge pressure gage	Ft. of water	1.229	1.229	1.229	1.229	1.229	1.229	1.229
26	Distance between suction and vol. pressure gage	Ft. of water	15.104	15.104	15.104	15.104	15.104	15.104	15.104
27	Velocity head at inlet to condenser	Ft. of water	0.484	0.741	1.115	1.602	0.685	0.510	0.358
28	Velocity head in discharge nozzle	Ft. of water	2.444	3.75	5.641	8.114	3.468	2.582	1.814
29	Net velocity head	Ft. of water	1.96	3.009	4.526	6.512	2.783	2.072	1.456
30	Total test head based on pressure gages	Ft. of water	190.36	187.19	170.83	180.34	157.16	150.08	146.63
31	Total test head based on vel. gages	Ft. of water	191.164	190.304					
32	Temp. of water at inlet to condenser	Deg. F.	73.4	73	73	71.9	71.9	71.9	71.9
33	Temp. of water at suction inlet to pump	Deg. F.	75	74.77	74.51	72.75	72.48	72.27	72.25
34	Water pumped by pitometer in suction main	M.G.D.	25.12	31.62	38.50	46.20	31.920	27.13	22.386
35	Water pumped by pitometer in discharge main	M.G.D.	25.50	31.54	38.70	46.38	30.325	26.20	21.934
36	Water pumped by suction main Venturi meter indicating	M.G.D.	24.5	30.43	37.18	44.87	29.6	25.94	21.74
37	Water pumped by suction main Venturi meter integrating	M.G.D.	23.58	29.52	35.83	44.16	28.56	24.96	20.64
38	Water Hp. by discharge main pitometer	Hp.	851.0	1,035.0	1,159.0	1,466.0	835.8	689.0	564.0
39	Duty per 1,000 lb. of steam test conditions	Millions ft. lb.	140.2	156.7	165.92	168.0	156.5	144.7	132.75
40	Duty per 1,000 lb. of steam test, contract conditions	Millions ft. lb.	144.5	160.2	169.0	170.25	160.3	148.7	137.3
41	Temperature of oil entering cooler	Deg. F.	106.9	107.83	107.5	106.17	100.5	99.17	98.58
42	Temperature of oil leaving cooler	Deg. F.	98.1	98.43	98	95.5	91.2	90.37	90
43	Nozzle press. Pelton water wheel	Lb. per sq.in.	118.43	116.66	108.01	108.30	103	102.22	101.11
44	Hurling water pump suction pressure	Lb. per sq.in.	8.469	8.469	8.469	8.651	7.517	7.585	7.62
45	Hurling water pump discharge pressure	Lb. per sq.in.	25.17	25.157	25.92	29.95	16.66	15.529	14.807
46	Press. hurling water at air pump	Lb. per sq.in.	30.6	30.1	29.8	35	37.22	38.3	37.66
47	Water used by Pelton wheel	Gal. per min.	62.1	61.6	59.4	59.5	58.0	57.7	57.4
48	Water used by air pump	Gal. per min.	552.0	548.0	547.0	591.0	608.0	655.0	613.0
49	Speed of main pump	R.P.M.	736.6	732.9	729.2	784.6	665	640.2	629.5
50	Speed of turbine	R.P.M.	3,208	3,192	3,176	3,417	2,896	2,788	2,741
51	Speed of Hotwell pump	R.P.M.	1,504	1,490	1,401	1,552	1,340	1,342	1,354
52	Total water pumped by main pump	M.G.D.	25.59	31.633	38.78	46.47	30.40	26.28	22.02
53	Total water Hp. obtained	Hp.	854.0	1,037.5	1,160.5	1,469.0	837.5	691.0	566.0
54	Brake Hp. at main pump shaft, estimated	Hp.	1,133.0	1,250.0	1,350.5	1,701.0	998.0	856.0	756.0
55	Efficiency of main pump	Per cent	75.1	82.8	85.8	86.2	83.7	80.5	74.6

The speed of the main pump was measured by tachometer and checked by a hand counter; the turbine speed was computed by the gear ratio (4.36). Pressure at the Pelton wheel nozzles was taken by gage and the discharge from nozzle rating.



PUMP CHARACTERISTICS OF MT. ROYAL CENTRIFUGAL UNIT, FROM OFFICIAL TESTS

During the tests, the unit was run usually for two hours at each point and readings taken every 5 min. for the more variable data (pitometers, gages, etc.) and every 10 min. for the steadier data (temperatures). Constant speed runs were made first at the 25.1, 33 and 38.5 m.g.d. rates. As the 33 rate was nearest to contract conditions this run was for 4 hours with readings at 10- and 20-minute intervals. The variable speed runs were made at delivery rates of 46.5, 30.5 26 and 22 m.g.d. During runs 5, 6 and 7, on account of the reduced speed, hurling water was taken from the suction main and correction made in the readings. The supply pump then furnished water to the oil cooler and bearings only.

Since the test, this unit has been run steadily and for the past two months continuously at a 40,000,000 gal. rate.

Traffic on English Railways in 1920

In a recent statement of the British Ministry of Transport on the operation of the railways in 1920 it is shown that net income in that year was 5 per cent greater than that in 1913, with a decrease in general merchandise tonnage of ½ per cent and a decrease in fuel tonnage of 20 per cent. Rates on general merchandise slightly more than doubled and rates on fuel increased more than 50 per cent. Passenger rates increased about 80 per cent. Receipts and expenditures for the two years were as follows:

	1913	1920
Total receipts	£129,700,000	£297,800,000
Total expenditures	83,500,000	250,800,000
Miscellaneous receipts	3,600,000	4,300,000
Net income	£49,800,000	£51,300,000

The number of passengers carried in 1920 was 1,566,834,000 compared with 1,507,117,000 in 1919, 1,184,196,000 in 1913. Season-ticket holders increased from 584,000 in 1913 to 1,015,000 in 1920. In 1913, 67,744,000 tons of general merchandise freight were carried; 225,554,000 tons of fuel, and 70,864,500 tons of "other minerals." In 1920 the freight record was: General merchandise 68,658,500; fuel, 181,166,000; other minerals, 68,053,000 tons.

How One Consulting Engineer Got a Job

Sidelights on the Business Side of Engineering in Designing Schoolhouses for the City of New York

By Elwyn E. Seelye
Consulting Engineer, New York City

ENGINEERS lately have been awakened to the fact that one of the reasons for their mediocre material success, as a class, is their lack of supplementary business ability. Many of them are in a state of economic bondage, because they are selling their time on a salaried basis rather than their engineering product as a commodity. Therefore, a little light on the subject may be of value. The relation between some of the ABC's of commercial engineering and the XYZ's of structural engineering is brought out in the following account of how an engineer sold his abilities to the contractor on New York Public School No. 50.

The typical school building in New York is T-shaped, the top of the T consisting of a five-story classroom wing with double rows of class-rooms and corridors down the middle. The leg of the T is the auditorium wing, which is two stories high. The auditorium itself extends under the five-story wing and a heavy girder of about 60 ft. span is required to support the third, fourth and fifth stories of the class-rooms above. The average structure contains about 100,000 sq.ft. of floor surface.

After the armistice, the architect of the Board of Education decided that the best interests of the city demanded that alternate bids be permitted on a reinforced-concrete frame for school buildings, though formerly the schools were designed with a fireproof structural steel frame. The alternate allowed the bidders full latitude regarding concrete system and spacing of columns but required the design to be made in accordance with the building laws and also that the architectural requirements be strictly adhered to.

FIG. 2. VIEW OF ONE OF THE AUDITORIUM GIRDERS DURING CONSTRUCTION

The wisdom of the architect's course in taking concrete alternates may be appreciated when it is considered that after the armistice there was a country-wide shortage of structural steel and that schools located outside of the city had long been built of concrete to the exclusion of structural steel. What is to be particularly commended is the fact that the architect

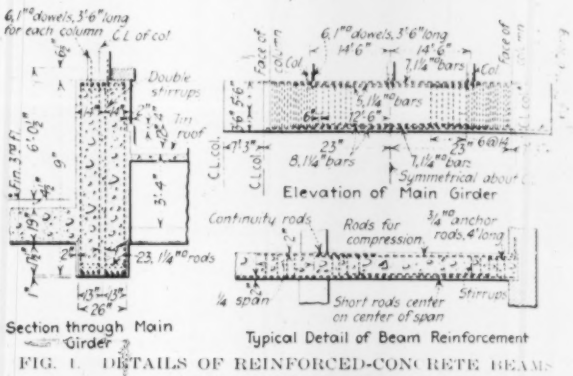


FIG. 1. DETAILS OF REINFORCED-CONCRETE BEAMS AND MAIN GIRDER

leaving the design open, permitted a full play for engineering talent.

As soon as the concrete alternates were announced engineering staffs of the bar companies and patented systems and one or two independent engineers pitted their brains against one another. Each competitor probably hoped to evolve a design which would sweep the field. However, owing to the fact that the successful contractors sat as separate judges on each job, no one competitor was universally successful and more than one drew a prize.

Unfortunately for the independent engineers, the question of bar delivery was very critical and they did not receive all the consideration which their designs merited according to cold figures, owing to the fact that they had no steel to deliver. But this disadvantage was partly offset because they had nothing but engineering service to sell and therefore were unbiased in their preliminary design.

A preliminary design and estimate had to be prepared for each job as an assistance to the general contractor in making up his bids, if an engineer was to stand a chance with the successful bidder. All the contractors were "from Missouri." This preliminary estimate was an expensive operation. The framing was very irregular and the jobs fairly large.

The writer went at the problem as follows: All different possible methods of design, such as combinations of clay tile, metal tile, beam and girder, flat slabs, etc., were considered, together with variations of column spacing, arrangement of framing, effect on architectural features, and wall types. Tentative designs reduced to cost, pointed to a simple beam and girder construction with bearing walls. Construction costs were built up from unit costs, somewhat as follows:

Having selected the proper design, the whole structure was designed and quantities taken off and a complete and reliable estimate of the quantities of concrete, steel and framework made up. The completed estimate was arranged as below:

Concrete—1:2:4	2,000 cu yd
Concrete—1:1½:3 (columns)	250 cu yd
Concrete—1:3:6 (foundations and walls)	500 cu yd
Reinforcing steel (above base size)	300 tons
Reinforcing steel (½ in. diam.)	50 tons
Cold drawn wire mesh	30 tons
Flat-slab forms	100,000 sq ft
Beam and girder forms per sq ft. of contact area	60,000 sq ft
Column forms, contact area	5,000 sq ft
Wall forms, contact area	10,000 sq ft

This simple form of summary is furnished more in detail for contractors who keep more detailed cost systems.

The next step was purely business. It consisted in interviewing the bidder and convincing him of several facts, namely: (1) That your figures were reliable. (2) That you had the knowledge, ability, and organization to turn out your plans on time and get them approved on time. (3) That the steel could be bought more economically on a pound price, based on a bar list, than on a lump sum. (4) That your design was inherently the most economical. (5) That your details would require the least amount of labor, bending, placing and formwork.

The contract for Public School No. 50 was awarded to the Putnam Construction Co. Its president, Mr. O'Rourke, a man familiar with both public schools and reinforced concrete, was an able engineer as well as a practical contractor. Mr. O'Rourke was convinced of the soundness of the writer's plans and, being desirous of incorporating many practical ideas of his own, decided to employ the writer and have him prepare a reinforced-concrete design and working drawings for the above structure.

An administrative problem now presented itself. The contract for the drawings called for their completion and approval on specified dates. In other words, this meant the simultaneous approval of the Board of Education and the Building Department at an early date after the completion of the plans.

The design was placed in the hands of an experienced designing engineer and the detailing in charge of a capable detailer. The detailing engineer kept in constant touch with the Board of Education and supplied it with the preliminary prints as the plans progressed. In this way, the early approval of the board was obtained. It was due to faithful compliance to the building laws and sound engineering practice, that the early approval of the Building Department was secured. It is worth while noting that the architectural requirements are exacting to a high degree in this type of work.

A very important feature in the economy effected in this structure consisted in detailing it with the straight loose bars graded as to length without laps, hooks or bends. This method is shown in Fig. 1. The bars were carefully graded as to length for moment and bond considered at the free or non-continuous end, all shear reinforcement being provided by stirrups. It is an indisputable fact that bends and hooks and extra length for anchorages would provide a greater shearing strength, but it is the duty of the engineer to eliminate all waste due to excess material or labor as well as to produce a design with a safety factor of four and no more. As all these items entailed a disproportionate amount of labor or material, they were consequently dispensed with and the design carried out in accordance with the American Concrete Institute committee's report of 1920. This recommends a shearing stress limit of 120 lb. for 2,000-lb. concrete, if properly anchored web reinforcement is used with steel in the top over the supports.

The selection of the type of construction was closely connected with the commercial aspects of the problem. Let us consider first the types of walls, which may be chosen; for instance, bearing, skeleton, or curtain walls. By way of explanation, it should be said that a curtain wall, under the nomenclature of the New York Building Law is applied to that wall which is built self-supporting but braced by wall columns.

After viewing the costs obtained from estimated quantities extended with unit prices, it was found that the curtain wall and the skeleton wall were the most economical types. There was, however, this to be taken into consideration. The school contractors are specialists and are experienced in one type of construction,

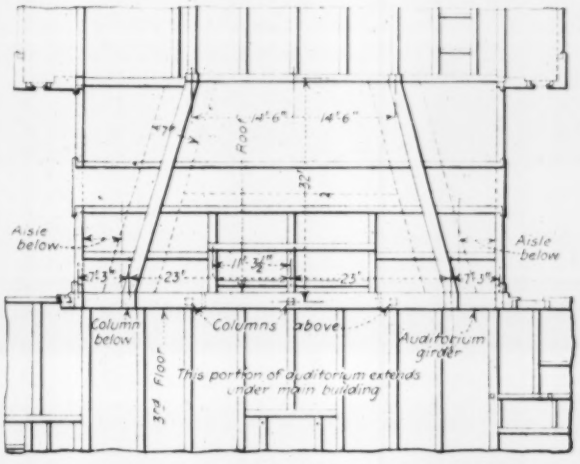


FIG. 3. LAYOUT OF BEAMS AND GIRDERS OVER AUDITORIUM

namely, a brick bearing wall school, with structural steel beams, girders and interior columns, fireproofed and arched with cinder concrete. They usually sublet the steel, floor arches and fireproof construction and lay their own brick work. Consequently they were experienced and efficient in the building of a bearing wall job, but were not organized for working a complicated reinforced-concrete job nor were there many sub-contractors so organized. They must depend for sub-contractors for the reinforced-concrete work on the more progressive of the cinder concrete arch men. Therefore, it will be readily seen that a bearing wall job, at least for a starter, presented ample opprtunity for the builder to take advantage of his own experience in brickwork and simplify the work of the reinforced-concrete sub-contractor For these reasons, a bearing wall design was adopted.

The next problem for solution was the type of reinforced-concrete construction. In general the various possible types or systems are: the beam and slab, metal core, one-way clay tile and two-way clay tile systems. Apparently the most economical of these systems is the core type of construction, but practical consideration swung the balance in favor of the beam and slab type. Since this design was made, there have been many improvements introduced in the removable metal core system which point to this system as a coming type for

all plastered ceiling or light live-load construction. The sub-contractors who were available were not familiar with the core system and therefore this system was discarded in favor of the beam and girder.

The next problem which presented itself was the designing in concrete within narrow restrictions as to size and width of certain members heavily stressed in moment and shear. This problem had already been solved in other school designs with the use of steel plate girders and triple rolled beams, but here heavily reinforced concrete girders were resorted to. The most serious case occurred where the auditorium extended under the main five-story structure and where a girder was required to span the width of the auditorium and carry three stories of walls and floors. This problem was attacked along the following lines: (1) The span was shortened. (2) The load was relieved by rearranging the framing. (3) Compression steel was introduced. (4) A raised girder of full depth between ceiling line and window sill was used. (5) A rich mix was used. The result was the girder shown in the view in Figs. 2 and 4 and in detail in Fig. 1.

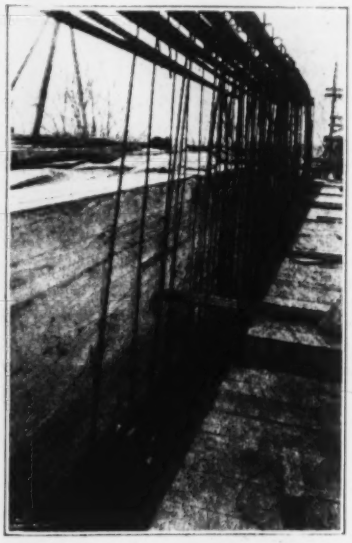


FIG. 4. LOOSE BAR STIRRUPS IN GIRDER

The span was reduced by placing the column just inside the side aisles where they did not obstruct the view of any seats and only sacrificed one seat each. The load was relieved by skewing two large auditorium roof girders to come directly into the columns (Fig. 3).

The modern school building is an aggregation of class-rooms but it has warm air arteries, breathing apparatus, thousands of cabled eyes, telephone nerves and abdominal passages. All these conduits must be accorded space and the structural engineer must allow for their free passage.

This article would not be complete without mentioning an intimate subject, that of the engineer's fee. The agreement made with the contractor required that a total lump sum fee be paid in installments, the last of which came due when the third tier had been completed. The salary and overhead cost were about 50 per cent, leaving a net profit of 50 per cent, which was satisfactory when the fact that this was an entering wedge job was taken into consideration and was the more difficult because it was the first of its type.

To sum up, this job is typical of nearly all entering wedge work. The contractors' engineer must create ideas which are attractive to a contractor. He must have an efficient organization to execute the work, the head of which should be working on a profit sharing or partnership basis, and he must handle the different organizations from which he must obtain information and approval with tact and consideration.

Alterations to Queen Lane Water Filters, Philadelphia

By John S. Ely

Assistant Engineer, Bureau of Water, Philadelphia, Pa.

THE Queen Lane water filter plant, Philadelphia, is being doubled in capacity by converting the preliminary filters to rapid or mechanical filters and continuing the present slow sand filters in use as such. Coagulating basins will be built for the mechanical filters. The present sedimentation reservoir will serve the slow sand filters only, thus nearly doubling the pre-sedimentation period. Other changes are noted in detail below.

The Queen Lane filter plant was built in 1909-1911 and is the latest of the five filter plants for Philadelphia. It was designed to furnish about 70 m.g.d. to districts in the North and Northwesterly section of the city. It is located in what was originally the north basin of the old Queen Lane reservoir. The south basin of the reservoir, having a capacity of 175,000,000 gal., is used as a sedimentation basin. The filter plant consisted of 22 slow sand filters of 0.75 acres each, 40 preliminary filters, each 32 x 40 ft., a 40,000,000-gal. filtered water basin, a power house, wash water tower and office building. As the plant is located in a residential section of Germantown, the area available was confined to the two city blocks on which the original basin was built and it was necessary to design the plant as compactly as possible. For this reason the slow sand filters were built above the filtered water basin, on groined arches.

This plant is nearer the center of the city than any of the others, and is advantageously located for supplying a large area by gravity. Therefore, as one of the first steps in the proposed increase of the water supply of the city, it was decided to increase the capacity of this plant. The 40 preliminary filters are in size and arrangement very similar to modern rapid sand filters, and by making changes in the interior piping and wash water systems and adding new filtering material, this portion of the plant can be readily converted into modern mechanical filters, with a capacity of about 100 m.g.d. The 22 slow sand filters will then be operated independently and should be good for at least 40 m.g.d. more, making a total of 140 m.g.d. or double the present capacity.

This arrangement, however requires the use of a coagulant in that portion of the water which is applied to the mechanical plant, necessitating the construction of additional basins and a head house for applying lime and alum.

As none of the surrounding property could be acquired except at almost prohibitive cost, the necessary space has been found for the required coagulating basins by excavating into the banks of the original reservoir. A head house has been designed to be located over the outlet end of the raw water pumping mains at the southwest corner of the plant.

This head house will be so arranged that alum and lime in proper proportions may be applied to only that portion of the supply which is to be filtered in the new mechanical plant, the untreated balance being diverted to the old sedimentation basin, and thence to the slow sand filters, or if desired the whole supply may be treated. The equipment will include dry feeding machines, solution tanks, concrete storage bins, electric hoists and hand traveling cranes for convenient

handling of the chemicals. The necessity for these is evident when it is realized that at the rate of 2 grains per gallon it would be necessary to use 1,200 lb. of alum per hour, or 14.4 tons per day.

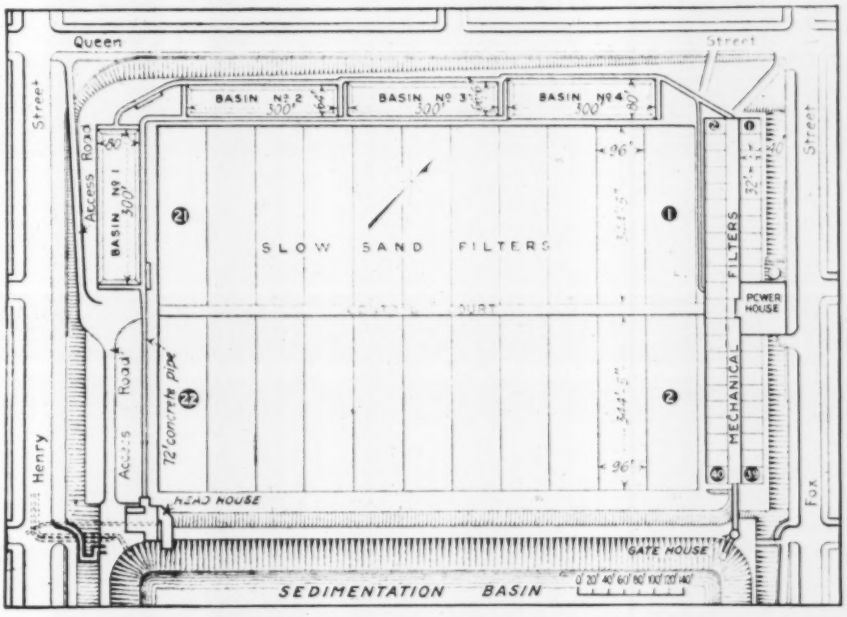
The treated water will be carried from the head house by a line of reinforced-concrete pipe 72 in. in diameter and 450 ft. long, connected at its lower end with a rectangular supply conduit running along one side of the basins. A similar conduit on the other side will carry the effluent from the basins to the mechanical filters. The basins are each 300 ft. long, but vary in width from 64 to 80 ft., according to the width of the original bank on which they are built. Their depth varies inversely as the width so that the basins have a uniform cross section of about 950 sq.ft., giving at a 100-m.g.d. rate, a mean velocity of 0.04 ft. per second and a sedimentation period of about two hours.

The basins have 9-in. concrete floors, reinforced-concrete side walls and have skimming weirs at the outlet ends. They are arranged to work in parallel, one-quarter of the supply passing through each basin, and any one may be placed out of service for cleaning by flushing through a 16-in. drain to the street sewer. The changing of the preliminary filters into a mechanical plant, while not requiring any great amount of new construction, is a somewhat slow and laborious process, especially so as it is necessary to keep as much of the plant in service as possible. During nearly ten years of hard service with Schuylkill water the sand and gravel have become quite thoroughly choked with mud and some of it has penetrated to the strainer systems and collectors, while part of the air piping is badly corroded. An entirely new strainer system has been designed which it is believed will prove more durable, and larger sizes of cast-iron piping are required to take care of the increased quantity of water to be filtered. These changes necessitate the removal of all of the old sand and gravel and some alterations to the concrete floors, roof columns and wash water gullets. The old sand cannot be used, but the gravel will be washed and replaced, and 30 in. of new filter sand placed upon it.

After the completion of the work already described, it is the intention to improve the south basin of the original reservoir, which is to be used as a sedimentation basin for the slow sand filters. This basin now has no baffles, and the inlet and the outlet are both on the same side, consequently there is a tendency for the water to run straight across the basin. A concrete inlet flume will be built along the west side of this basin and so arranged as to distribute and aerate the raw water. Baffles of A-frame or similar construction will be built across the basin and so arranged as to give a maximum period for sedimentation. It is believed that this improvement will enable the present final filters to take care of considerably more water than the 40 m.g.d. already mentioned.

In connection with the work outlined, the equipment of the Queen Lane Pumping station, which supplies raw water to the filters, is to be entirely renewed. The four old vertical triple expansion pumps are being replaced, one by one, by four turbo-centrifugal units of 40 m.g.d. capacity each. The boiler capacity is to be increased from 2,800 to 4,000 hp., and new coal bunkers and coal and ash handling machinery will be installed.

The two 48-in. force mains to the filter plant, about two miles distant, will be supplemented by a 60-in. steel pipe line.



GENERAL PLAN OF REMODELED QUEEN LANE FILTERS

The designs for the alterations outlined were made under the direction of George W. Fuller, who was retained by the city as consulting engineer. The work is being done under the direction of Carleton E. Davis, chief of the Bureau of Water. Edward Fay & Sons, Philadelphia, are the contractors for building the new basins and head house, which are now about one-half completed.

Water Jacketing Concrete Pressure Pipe

Reports from Germany state that a new method of preparing concrete pipe for high pressure resistance is being experimented with. The basic principle is to encase the pipe-line carrying the pressure in one of larger diameter, and to keep the intervening space between the two pipes under water pressure of about half the head prevailing inside the smaller pipe line. The water jacket counteracts the water pressure of the internal pipe line to an extent equal to its own pressure. In this way, according to the report, reinforced-concrete pipes can be used for carrying water under double the pressure which they are normally able to resist. The structure is made more rigid by placing webs radially between the two pipes. It is claimed that this greatly helps to resist high pressure of ground and the shocks from traffic. It is suggested that the effect obtained can be multiplied by using more than one casing.

A Plan for Meeting Water-Supply and Sewerage Costs

Distribution of First Cost and Operating Charges in Accordance with Public and Private Benefits—Capital Charges End with Life of Bonds—Application of Plan to Suburban District

By Robert B. Morse
Chief Engineer, Washington Suburban Sanitary District; Chief Engineer, Maryland State Department of Health

AND

Abel Wolman
Division Engineer, Maryland State Department of Health, Baltimore, Md.

THE plan for meeting both capital and operating costs of water and sewerage systems outlined in this paper is founded upon two primary principles, one that public and private benefits should be separately considered, the other that fixed and operating charges represent two classes of costs whose payments should be differentiated. By this method, the installation of both water supply and sewerage systems is paid for by a combination of property tax, annual front-foot assessment, house connection cash payment, meter service charge, and water consumption charge. The general distribution of these charges is as follows:

1. Fixed charges: (a) The general tax is used to pay only that part of the cost of water and sewerage construction which is of value to all the taxable property, such as reservoirs, pumping stations, treatment works, supply and outfall lines. (b) The front-foot assessment pays for that part of the cost of service which is of special value to properties along water and sewer lines. (c) The payment for house connections includes cost of work from water or sewer main to property line.

2. Maintenance and operating costs (d) The meter service charge covers the "ready-to-serve" portion of the operating costs. (e) The water consumption charge provides for the fluctuating costs of maintenance and operation of both water supply and sewerage service.

This plan is now in operation in the Washington Suburban Sanitary District in Maryland. While all the elements contained therein are not new, it is believed that it represents a unique co-ordination of all of them, at any rate in a general water supply and sewerage district.

Differs From the Brockton Plan

In addition to covering water supply as well as sewerage construction and operation, the system differs from the well-known Brockton sewerage method in two major and in several minor respects. It makes (1) a fundamental distinction between capital and operating charges and, (2), provides for a flexible adjustment of relative charges in accordance with variations in systems. The Brockton plan does not emphasize either of these considerations, but, perhaps on account of legal and local restrictions, distributes inflexibly and definitely the charges between general tax, assessment, and consumption classes. Both plans employ the same sources of revenue, since these are the only possible ones, but they differ completely in the fundamental philosophy of distribution of charges between these sources.

Methods of Paying for Systems—The usual methods of paying for municipal water and sewer construction and operating costs fall into one or more of the following classes: (a) general taxation, (b) special assessments, (c) rates based upon service. The use of any single one of these methods of payment would impose an undue burden upon many properties, since no one of them is equitable in its distribution of costs.

Manifestly any plan of meeting the costs of construction, maintenance, and operation of water supply and sewerage works should be founded upon the principle that the expense entailed upon any individual, public or private, should be proportionate to the benefits which he derives. A thoroughly equitable financial plan for constructing and operating water and sewerage systems must involve a combination of all the three methods indicated above. The mere presence of waterworks or sewerage in any town is of value to all of the taxable property, remote though it may sometimes appear.

The only portion of the cost of water and sewerage service that should be allocated to the tax rate is the measure of value that such service represents to all the taxable property, unless a graded plan of taxation on the basis of geographical location is used.

That part of the cost of service which represents a special value to all properties, vacant and improved alike, along water and sewer lines may be reasonably met by special assessment. The amount of this special assessment should be as closely as possible proportionate to the expense that the mere presence of the property entails upon the system. This expense is determinable by the length that the property binds upon the public way in which the pipe line is placed. In the case of a system properly designed this assessment should be independent of the size of the pipe in the street.

Special Assessments for Portion of Cost

The third class of benefit, and the greatest, is enjoyed by the developed properties along the pipe lines, and it is the connection of such properties with the system and their use thereof which give rise to the major part of the costs of maintaining and operating the system.

An exact analysis of the benefits received by the various classes of property above discussed is difficult of accomplishment. The problem may be solved, however, with a degree of approximation which will give a reasonably fair division of costs. The solution necessarily will be governed somewhat by local prejudices, and policy frequently dictates that such prejudices should determine the absolute amounts of the several classes of charges. Local feeling, however, should not be allowed to destroy the fundamental philosophy of the plan. There should be firm adherence to the principle that capital cost be met by the tax rate and by front-foot assessment, and that expense of maintenance and operation be covered mainly, if not wholly, by charges for service rendered.

It is convenient and substantially equitable to measure the value of a system to all the property in the community (that is, the charge to the tax rate) by the capital cost of the main elements of the system, such as reservoirs, pumping stations, treatment works, supply and outfall lines, and that portion of the cost of main arteries and collectors which would represent the excess of their cost over that of equal lengths of small

distributors and laterals. The front-foot assessments should meet the cost of the pipes and appurtenances necessary for bringing water, including that for fire fighting, to, and conveying sewage from, local areas. The assessment charge, however, should not include the cost of water and sewer connections. The expense of constructing these, which from the main to the property line should be done by the municipality, should be met by a charge, preferably a uniform one, upon the properties connected. The expense of making these connections represents, to a great extent, the particular benefit that a built-up property receives. If more nearly theoretical accuracy is desired, it may include the cost of fire hydrants and their connections. If so, the assessment charge is relieved of this cost.

Universal Metering Accepted Desideratum

On the maintenance and operating side the principle of universal metering is here assumed as an accepted desideratum. The cost of water delivery and pipe upkeep should be met by a "ready-to-serve" and a consumption charge. If the meter is furnished by, and remains the property of, the municipality, as is desirable, the "ready-to-serve" or so-called "service" charge should include an element to cover the fixed charges on the cost of the meter, unless its cost is included in that of the house connection. Whenever there is an antipathy towards sewer rentals as such, it is in a measure equitable to cover the cost of maintenance and operation of the sewerage system by an increased charge for water.

The question may naturally arise as to the manner of raising sufficient construction funds where capital costs are not wholly met by the tax rate, whether with or without the issue of bonds. To the writers it does not appear practicable or desirable to start upon a new improvement of any magnitude without the issuance of bonds. It is not necessary, however, granted proper legislative authority, that more than that proportion of the fixed charges which has been above specified as correct be borne by the tax rate. The remainder should be met by the front-foot assessments and the connection charges. Barring local legislative prohibition, the former may be made payable upon the commencement of construction in that area in which the assessments apply. If the assessment and connection costs are made payable in one or a few installments, a revolving fund will be created which will reduce the amount of future bond issues. However, this arrangement often results in a heavy burden upon many property owners. It is entirely feasible to impose an assessment charge on the basis of a few cents per front foot a year and to cover the house connection charge by a very small annual payment, both continuing during the life of the bonds. These need be sufficient in amount to cover only that part of the annual fixed charge on the bonds that is not to be met by direct taxation. If this is done the assessment becomes nothing but a small annual expense, which is practically the same as a slight increase in taxation for those along the pipe lines, and the payment for connections an additional service charge.

In the application of the plan here under discussion to particular localities it may be found advisable in many cases, for the purpose of front-foot assessment, to classify properties in a community in accordance with the uses to which they are put, imposing different unit rates upon each class. This is done to avoid burdens or prohibitive charges against properties with long frontages. This method is rational and equitable for the reason that some kinds of property, business and industrial, for instance, enjoy relatively greater advantages from the presence of adequate water supply and fire protection systems, and perhaps of sewerage systems, than do residential properties. Likewise, small residential or subdivision properties are more dependent upon water and sewerage service than is acreage or agricultural land. The more intensive the development, in general, the greater the benefit and the greater the capability of bearing the burden.

For the purpose of further decreasing the charges on long frontages it has been found necessary in some instances to establish a sliding scale of front-foot rates for a given class of property, decreasing the unit with an increase of frontage. In this case, if the property is later subdivided, or its character changes, its unit assessment would be modified to suit the new condition.

The advisability or necessity of classifying properties or of applying a sliding scale of assessment naturally depends upon the municipality or locality under consideration. Local conditions must govern, but the equities are such that departure from fundamental theory is not important.

Application of Plan in Washington Suburban Sanitary District—The Washington Suburban Sanitary District is an area of 95 sq.mi., with a population of approximately 35,000, comprising parts of two counties in Maryland adjoining the District of Columbia. Numerous small incorporated communities and unincorporated villages closely adjoin each other in many parts and are scattered at greater intervals in other sections. Much of the territory is distinctly suburban, but there are still extensive rural areas.

Water supply and sewerage facilities were inadequate, and in some instances entirely absent. General sanitary conditions were bad and were becoming worse with the failure to provide for the future. In order to remedy these conditions by the installation of adequate and comprehensive water and sewerage systems, the Sanitary District was established by the Maryland Legislature of 1918. The area was chartered as a municipal corporation for the above purpose. It was given the power to issue its own bonds, lay its own front-foot assessments, and to fix the amount of additional tax to be levied within the district by the two boards of county commissioners. A commission of three residents, William T. S. Curtis, T. Howard Duckett and Emory H. Bogley, constitutes the administrative body.

Four Land Classifications

Construction and operation of the general systems are being carried on under the financial plan described in this paper. Land is classified as industrial or business, subdivision, small acreage, and agricultural. Subdivision property is defined as land platted into lots, blocks or squares. All property not so platted, where the total area does not exceed 15 acres, is classed as small acreage, unless it is used exclusively for agricultural purposes and is not within an incorporated town. All other land is designated as agricultural.

Front-foot assessments are uniform within prescribed areas where construction work is to be undertaken. They begin to be payable at the time a project in any section is started. While established on the basis of an annual charge per front foot during the life of the

bonds, any assessment may be paid, within one year after levy, in one prescribed sum sufficient to cover the proportionate share of the cost of the construction work. Assessments on business or subdivision property may be extinguished, at any time, by the payment of a sum which if put at interest at 3½ per cent, compounded annually, would yield an annuity equivalent to the annual assessment for the period during which the bonds have still to run.

With the exception of lots of irregular shape, relative to which the commission is empowered to use its judgment, all subdivision properties are assessed for their full frontage even though the water or sewer line does not extend along its entire length. Corner lots in this classification are assessed on only one side, as these obtain no greater benefit than do the interior lots of the block.

High Prices Taken Into Account

As the construction work in the district was commenced during an era of extremely high prices, in order not to penalize too greatly the property owners of those sections in which the first work has been undertaken, the assessment rates in such areas have been fixed at figures slightly below those necessary to carry the bonds so far issued, but sufficiently high, it is believed, to provide for the fixed charges on all the district bonds that will have been issued after a period of years, if the same charges are levied for construction that will be completed at considerably lower prices. This will penalize to some extent those sections in which construction work is delayed. Under the enabling act, front-foot assessments once laid on a property cannot be increased, although they may be diminshed, should conditions so warrant. If there is disappointment in not attaining much lower costs of construction, front-foot rates on properties later brought under assessment will have to be raised somewhat, or deficiencies may be wiped out by a comparatively small increase in the general tax. At this date the situation is being materially aided by investment of the sinking fund in liberty bonds, through increased interest rates, and it will be greatly helped in the future when the accumulated yield of these bonds becomes available.

In order to cover periods of changing costs, where the installation of improvements must continue over a considerable number of years and be done by the periodic issuance of bonds, it appears to the writers that the best plan would be to change annually the rates for front-foot assessments uniformly throughout the jurisdiction, to suit the needs of the ensuing year, just as is done in the levy of taxes.

The tax, front-foot assessments, house-connection charges, service and water rates (including sewerage service) in the district are at present as follows:

General tax, 4c. per $100 of assessed valuation

Front-foot assessment (annual per foot)	Water	Sewerage
Business or industrial property, first 200 ft.	14c.	8c.
All excess	7	4
Subdivision property, first 150 ft	9	6
All excess	3	2
Small acreage property, first 150 ft.	9	6
2d 150 ft.	3	2
All excess	1	1
Agricultural property	9	6
(No assessment unless connected, and length assessed limited to 150 ft.)		

Water connection $25, sewer connection $25, amounts payable in one sum or in four annual installments, the deferred payments bearing interest at 6 per cent.

Meter service charge, $4 annually for 1-in. meter, increased amounts for larger-sized meters.

Water consumption charge (includes sewerage service) for all water registered.
15c. per 1,000 gal., up to 25,000 gal. semi-annually
14c. per 1,000 gal., next 25,000 gal. semi-annually.
13c. per 1,000 gal., excess over 50,000 gal. semi-annually.
No rate fixed for very large consumers as none has yet been connected.

It may be of value to give an example of how the annual cost of water and sewerage service, exclusive of initial payment for house connections, works out in actual practice for a residential property.

Description	Tax	Assessment	Service Charge	Consumption Charge	Total
Property assessed at $5,000 Frontage 60 ft. Annual consumption 40,000 gal.	$2 00	$9 00	$4 00	$6 00	$21 00

General Application of Plan—The plan which has been described for financing the construction and operation of water supply and sewerage improvements is applicable not only to the installation of new systems in cities, towns, unincorporated county areas and joint districts consisting of a number of municipalities, or of municipalities and unincorporated territory, but with proper adjustment for taking care of past obligations and existing methods of individual payments it may be more or less readily applied to extension projects. The essential for maximum effectiveness is a central organization for ownership and control, with power to issue its own certificates of indebtedness, to proceed with all new work as its judgment may dictate, to purchase, condemn or otherwise to incorporate previously installed systems, and to readjust prior financing, both with respect to the bondholders and the citizens. In the case of a district formed from minor political subdivisions, opposition to the transfer of ownership of municipal and private systems may be encountered. However, in many cases, as in that of the Washington Suburban Sanitary District, the receipt of full remuneration for perhaps a broken-down or obsolete system, followed by a reduction of the local tax rate or the elimination of responsibility for giving service, or both, will be welcomed by municipalities, private companies and realtors.

Plan Applicable to Extensions

Particular stress may be laid upon the ease with which the plan lends itself to the construction of extensions wherever they are needed, either for convenience, the protection of the public health, or for the stimulation of development. Each extension is self-supporting from the beginning, there is no need of deposits being paid into the public's treasury before the construction work will be started, and there is no cause for the installation of extensions or of isolated systems on the part of those developing land.

The construction of adequate water and sewerage works in small villages is just as feasible under this plan as in the larger towns or in cities. Perhaps the most important engineering activity of the Maryland State Department of Health is the encouragement of movements for the installation of proper water and sewerage systems in the various towns of the State. Until a year or so ago the fight was an up-hill one. Excessive increase of tax rates was the obstacle. Beginning only a few months prior to the legislative session of 1920, at the peak of construction costs, an exposition of the plan described in this paper as it would relate to individual towns resulted in the passage of several acts for the construction of water and sewerage systems, embodying the methods of payment used in the Washington Suburban Sanitary District. One act provided for the issuance of bonds to the amount of $60,000 for a public water supply in a town of 600 inhabitants. Another village with a population of less than 400 was allowed a bond issue of $55,000 for complete water and sewerage systems. Since then the Department of Health

has been prosecuting a systematic campaign in a large number of municipalities. Rough layouts and preliminary estimates of cost are made, the approximate length of assessable frontage is ascertained, and a practicable scheme for local financing is worked out. The total expense to similar properties is found to be practically independent of the size of the town.

When it is discovered that, even under present conditions, the total annual expense to the small property-holder for adequate water supply, fire protection and sewerage service will vary from perhaps $15 to $30, and the blighting effect of a high tax rate is avoided, local interest is invariably immediately aroused.

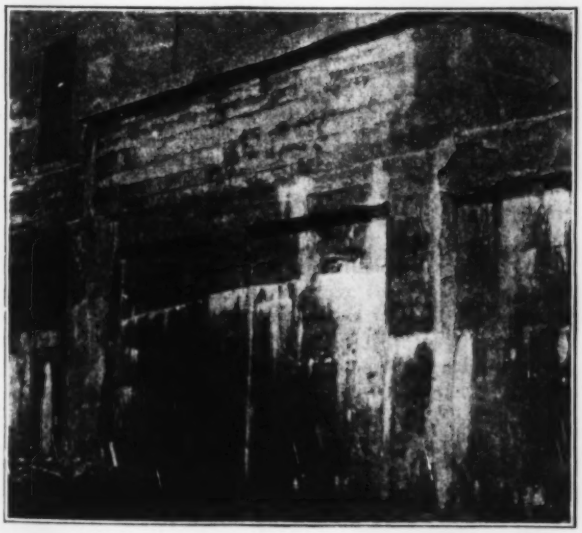
The efforts of the State Department of Health are not being confined to individual towns, but are being extended to encouraging the establishment of water and sewerage districts consisting of favorably located communities or of the larger towns and their unincorporated suburbs. In the latter case the extension of municipal systems into sections which have not been able to obtain improvements under county government is rendered feasible. Progress is now being made towards the formation of a water and sewerage district in the Georges Creek region where within a comparatively small area there are communities with an aggregate population of over 30,000 which now have inadequate facilities.

Porous Filter Walls and Dams Spall Under Frost Action

APPARENT failure of the concrete in the filter plant and at two mountain dams of the Cheyenne municipal water-works has finally been diagnosed as due to freezing of the seepage through porous concrete. J. A. Whiting, city engineer, gives the following results of the investigations.

At the filter plant he states that conditions are as follows:

(1) The concrete disintegrates and falls off of all outside walls where water is in contact with the walls on the inside, except below the ground level where the concrete seems to be as good on the outside as it is on the inside.



SPALLED FILTER WALL SHOWING SEEPAGE

(2) The concrete disintegrates on the outside of the walls for 18 in. above the high water line wherever water has been standing continuously.

(3) The beams supporting the roof over filter beds, 3 ft. above water, show some disintegration.

(4) The inside of all outside walls below the water line are in perfect condition.

(5) All outside walls below the ground level, having water on the inside, appear to be in perfect condition.

(6) All concrete baffle walls inside of the filter plant appear to be in excellent condition.

(7) All walls either inside or outside that do not come in contact with the water are in splendid condition. An examination of samples sent to Prof. D. A. Abrams, Structural Materials Institute Research Laboratory, Lewis Institute, Chicago, indicated no increase in the magnesia or sulphuric anhydride as one would expect if the concrete were disintegrated by the action of alkali waters. There was no indication that the use of alum in the water had any influence on the behavior of the concrete. Analyses of the city water show an alkalinity of 81 p.p.m.; $CaCO_3$, 67.4; $MgCO_3$, 2.8; $MgSO_4$, 14.6; $NaSO_4$, 9.6; NaCl, 6.3 p.p.m., indicating a comparatively soft water.

DETAIL OF SPALLED PILASTER

In the fall of 1920 when Mr. Whiting visited the two concrete dams in the mountains he found water seeping through them in small streams and freezing in large masses. Apparent failure of the concrete similar to that at the filter plant was observed.

The settling basin walls and other parts of the filter plant, the outside portions of which have shown signs of disintegration, have been covered with two coats of waterproofing paint made up of 16 parts of refined coal tar pitch, 4 parts of portland cement and 1 part of kerosene. The cement and kerosene mixture was stirred into the hot tar but the mixture was applied cold. So far the waterproofing has prevented percolation. If it continues to be successful the dams will be treated similarly during the summer.

Concrete Paving Record Broken

A record of 1,105 ft. of 18-ft. concrete pavement, averaging 7⅞ in. thick, was recently made in 9 hours on Federal Aid Road No. 43, being constructed for the Michigan Highway Department in Muskegon County. The contractor was Carl Scharl, Muskegon, Mich., operating the outfit described in *Engineering News-Record* Oct. 2, 1919, p. 658. Previous high records are reported in *Engineering News-Record* Feb. 3, 1921, p. 222.

Reservoir Capacity Curves Without Topographic Survey

By C. C. Jacob
Hydraulic Engineer, Salt Lake City; Federal Court Water Commissioner for Uintah Basin, Utah

A NUMBER of storage reservoirs are in operation, particularly in the West, for which accurate capacity curves have not been determined, usually through lack of topographical data. Where natural lakes have been developed as storage reservoirs by raising their water surface, it is frequently impracticable to secure a topographical map of the lake bed. The following method was developed to determine the capacity curve of such reservoirs, and also as a check on capacity curves determined in the usual way from topographical maps. It is based on the method previously published by the writer for determining rating curves on rough mountain streams impossible of direct measurement. (See "Indirect Method for Determining Station Rating Curves," *Engineering News-Record*, Sept. 30, 1920, p. 666.) The theory in both cases is precisely the same.

To apply the method, it must be possible accurately to measure the inflow and outflow at different stages of the reservoir for short periods of time. It is not necessary, however, to secure continuous records of flow for an extended period. The time interval is made as short as practicable to eliminate seepage and evaporation losses from the problem.

Consider any reservoir whose capacity curve is unknown. At any stage H (H being the elevation of the water surface above the outlet gate) the inflow Q', and outflow Q'' are measured as accurately as possible, the gates being adjusted so as to make ΔQ (the quantity of water stored or released) as large as possible for the period, which ordinarily should extend only for a few hours. The change in the water surface elevation during the period, ΔH, is also measured. Similar determinations are made at different stages of the reservoir, up to the maximum stage, if practicable.

The observations need not be made consecutively or even the same year. If the gates cannot be manipulated for the determinations, actual records of inflow and outflow and reservoir stage incidental to the regular reservoir operation can be used, but as many values as possible should be secured to insure that errors in the record are compensated.

A curve (Fig. 1) is plotted from the data secured as follows: ΔQ is the water stored or released during the interval, corresponding to a change of reservoir stage, ΔH. Values of $\Delta Q_1/\Delta H_1$, $\Delta Q_2/\Delta H_2$, $\Delta Q_3/\Delta H_3$, etc., are plotted as absissae and the corresponding average stage of the reservoir H_1, H_2 H_3, etc., as ordinates and a smooth mean curve drawn through the points. Then at any point on this curve ($\Delta Q/\Delta H$, H) the area between the curve and the H axis is equal to the capacity of the reservoir at that particular stage. That this is true is easily seen from the fact that the elemental area under the curve $\Delta A = \Delta Q/\Delta H \times \Delta H = \Delta Q$. Hence $A = Q$, the capacity of the reservoir, up to that point.

INDIRECT DETERMINATION OF CAPACITY CURVE, PIUTE RESERVOIR, NEAR MARYSVALE, UTAH

Records for 1914

Date	Mean Gage H.	Acreage Inflow	Feet of Outflow	Difference ΔQ	ΔH	$\frac{\Delta Q}{\Delta H}$	H
Aug 13	56 56	1,016	2,024	1,008	0 56	1,800	56 2
Aug 15	56 01						
Aug 28	51 14	1,208	2,468	1,260	0 74	1,710	50 77
Aug 30	50 40						
Aug 16	55 68	928	2,112	1,184	0 72	1,645	55 32
Aug 18	54 96						
Sept 7	47 64	1,040	2,412	1,372	0 81	1,695	47 24
Sept 9	46 83						
Sept 14	43 38	1,044	2,992	1,948	1 27	1,530	42 74
Sept. 16	42 11						
Sept. 18	40 80	1,048	2,852	1,788	1 30	1,375	40 13
Sept. 20	39 50						
Sept. 28	35 43	604	1,540	936	1 02	920	34 92
Sept. 30	34 41						
Sept. 25	36 49	376	1,576	1,200	1 06	1,130	35 96
Sept. 28	35 43						

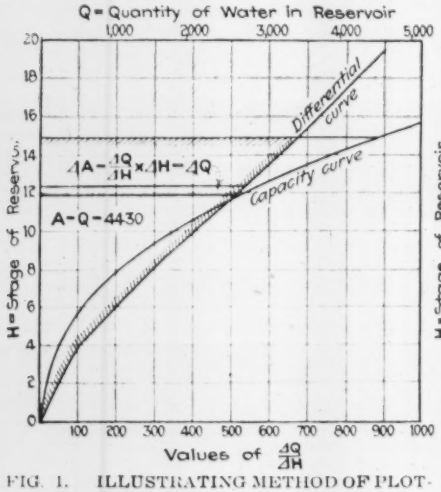


FIG. 1. ILLUSTRATING METHOD OF PLOTTING RESERVOIR CAPACITY CURVE
Based on inflow, outflow and steam heights.

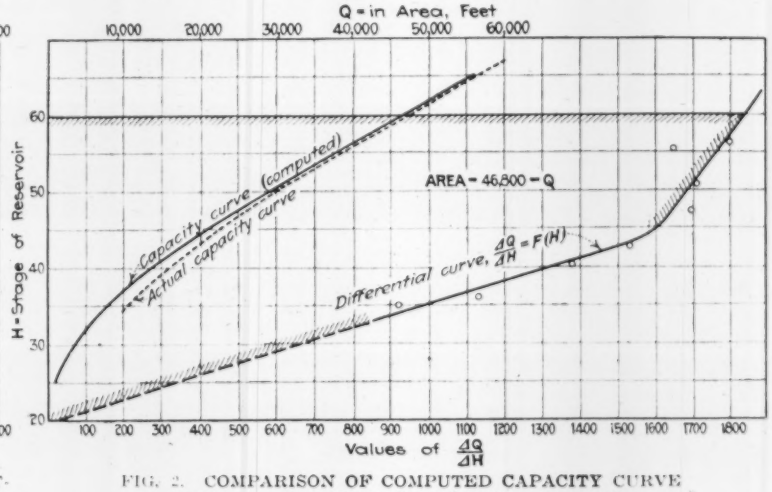


FIG. 2. COMPARISON OF COMPUTED CAPACITY CURVE WITH CURVE DERIVED FROM TOPOGRAPHIC SURVEY, PIUTE RESERVOIR

The accuracy of the determination will of course depend upon the accuracy of the observed quantities ΔQ and ΔH. With reasonable care, where conditions can be controlled, it should be possible to determine the capacity curve with a high degree of accuracy, comparable with the results secured from accurate topographical surveys, and with comparatively slight expense.

As an actual test of the method, it was applied (Fig. 2) to a reservoir where the capacity curve had been previously determined by topographical survey, and fairly accurate records of inflow and outflow were available—the Piute Reservoir on Sevier River in Utah. The resulting curves illustrate the method and show the

comparative results obtained. The data used were from the actual operation records for 1914, furnished by the U. S. Geological Survey. The length of interval used was two days. The resulting capacity curve is seen to agree very closely with the curve developed from actual survey for the middle and upper sections. The divergence of the lower part of the curve from the actual curve is accounted for by lack of data covering the lower stages. More satisfactory data could be secured by making field observations for the specific purpose of determining the capacity curve.

Cleaning a Railway Water Main

Abstract of paper by F. D. Yeaton, assistant engineer, C., M. & St. P. Ry., appended to report of committee on Water Supply, American Railway Engineering Association.

HIGH cost of cast-iron pipe and of pipe laying should make the subject of cleaning water mains unusually attractive. Municipalities have done considerable pipe cleaning, but railroads have done comparatively little. At Belle Plaine, Ia., a 6-in. pipe line, 8,000 ft. long, delivering water to an engine terminal, had its carrying capacity reduced about 10 per cent due to a rough hard scale, $\frac{3}{16}$-in. thick.

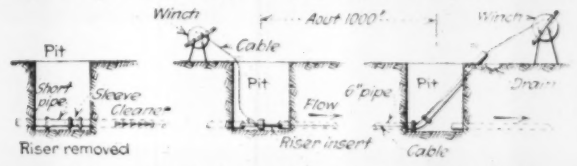


FIG. 1. METHOD OF CLEANING A WATER MAIN

This pipe line was cleaned in 1,000-ft. sections, two places 1,000 ft. apart being uncovered, the water shut off and a 3-ft. section of pipe removed at each place. A cable carrier and special riser pipe were inserted at the opening nearest to the pump and a 45-deg. elbow and short length of pipe were connected to the other opening, as shown in Fig. 1. Water was then turned on and forced the carrier, to which was attached a $\frac{3}{16}$-in. steel cable, through the pipe, as in Fig. 2. A $\frac{3}{4}$-in. cable was then attached to the $\frac{3}{16}$-in. cable and pulled through by a hand winch. The water being shut off and the riser removed, the scraper or cleaner was attached to the $\frac{3}{4}$-in. cable and inserted into the main, which was then closed by a short piece of pipe, as shown at the left in Fig. 1. The water was again turned on and the

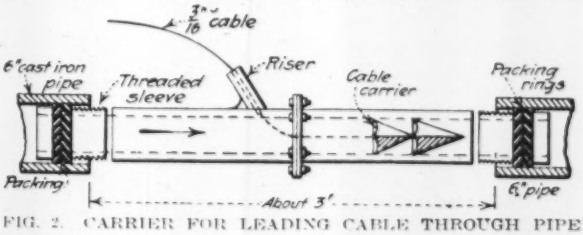


FIG. 2. CARRIER FOR LEADING CABLE THROUGH PIPE

cleaner was pulled through by the $\frac{3}{4}$-in. cable and a hand winch operated by four men.

The supervisor was furnished by the contractor and the necessary force by the railroad company, the force consisting of a foreman, a calker, a carpenter (to sheet and brace the pits) and eight laborers to dig the pits and operate the winches. A rough estimate of the cost, including transportation, labor, superintendence and equipment was $200 per day. The length of straight pipe cleaned per day was 1,000 ft., or an average cost of 20c. per linear foot. The cleaner will operate through a 45-deg. elbow and is reported to have passed a long 90-deg. bend. It requires about 30 lb. pressure to force the cable carrier through the pipe at a speed of 5 to 10 ft. per min. The rate at which the cleaning can be done depends upon the thickness and hardness of the scale as well as upon local conditions.

Improvements Required in Road Building Plant

Small Units Excel Large Units—Central Mixing Plants Require Standardizing—Paving Mixers Too Heavy

BY B. H. PIEPMEIER
Engineer of Construction, Illinois Division of Highways, Springfield, Ill.

Condensed from a paper read before the Materials Handling Section of the American Society of Mechanical Engineers at the Chicago Meeting of May 23-26, 1921.

IN GENERAL, the building of a system of roads requires the installation of a number of small plants in preference to a few large plants. In the past this has been particularly true, first, because of inability to secure experienced and capable superintendent for large plants; second, because the railroads have failed to deliver sufficient materials to keep large plants working efficiently; and third, because of the frequent breaking down of machinery. With large plants the breakdown of one machine delays the entire operation, although the small construction unit necessitates many operations by hand at somewhat greater expense than if performed by machinery. When the final analysis is made the small unit will show high efficiency on account of the possibility of often operating it independently of any particular machine that may be out of service on account of a breakdown.

On account of the conditions that have existed during the past few years it has not been possible for the contractor with the large plant to show a fair profit. These conditions have been inadequacy of railway transportation,

CENTRAL MATERIALS YARD WITH LOCOMOTIVE CRANE

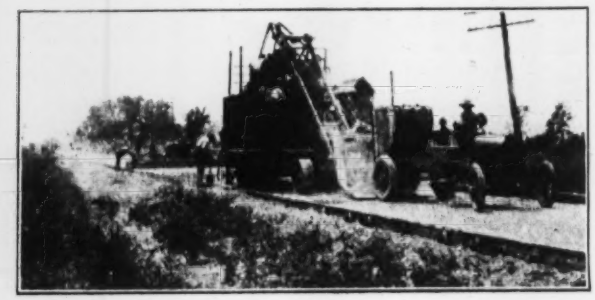
uncertainty of labor conditions in the manufacture of both road machinery and materials, and inefficiency of the men on the work.

Many breakdowns have been caused by the inefficiency of the labor used in the manufacture of the machine and in its operation on the job. Constant breaking has not only put an individual machine out of service but also other equipment which depended upon it. Contractors need to give more thought to the design of road plant so that its successful operation may not depend upon one machine. Many already realize that it is economy to duplicate machines. Some contractors have installed a duplicate pumping system for the supply of water. The additional cost of the duplicate unit is small compared to the advantage of being able to operate the plant without a delay. In many instances contractors have duplicated concrete mixers. The average road job may not always justify complete duplication of the mechanical units, but where there is a large season's work a careful investigation is required of the advantage of duplicate units.

As most specifications now prohibit materials from being stored upon the subgrade, the contractor is compelled to provide transportation, either by industrial railway or motor trucks. The industrial railway, under normal conditions, will insure a more uniform delivery of materials, regardless of weather conditions, than any other method.

The chief objection to it, however, is that it is limited to road construction having grades ordinarily less than 4 per cent and where there are few railroad crossings. Then, too, its high initial cost demands that a large mileage of roads be built each year in order to absorb the interest on the investment and the depreciation.

Truck delivery has superseded team delivery as it is much more rapid and will carry material to a paving mixer or from a mixer direct to the road with less disturbance to the roadbed. Truck transportation is very flexible and is therefore better suited to various sections of work than



TRUCK HAULAGE OF DRY BATCH TO PAVING MIXER

perhaps any other method. It is especially suited to the delivery of mixed concrete from a central plant to the road being improved and to the delivery of proportioned batches direct to the paving mixer or to a point where the batch boxes may be transferred to a short line industrial railway which in turn delivers them to the paving mixer.

The delivery of mixed concrete from a central mixing plant direct to the job has been attracting considerable attention. This method is worth a careful study as it permits centralization of the contractor's operations and enables him in many instances to economize in his plant and operating expenses. Central mixing plants should be simple in operation and reasonably uniform in design. A study of central plants shows that no two have been very similar in design. It would seem possible that the operation of unloading aggregate and cement from railroad cars and then mixing the materials to the desired proportions and consistency could be standardized to such an extent that central plants could be simplified and made more economical in operation. The mechanical engineer and the equipment designer should lend their assistance.

Central mixing plants may be fairly uniform in design, but the delivery of the concrete from the plant to the road will vary considerably to fit the existing local conditions. Mixed concrete may be delivered by industrial equipment provided there are reasonably short hauls and the equipment is designed for small loads with considerable speed in the transportation. The small truck will usually prove to be the most efficient machine for the delivery of mixed concrete as it will take the full batch direct from the mixer to the road in the least possible time.

Delivery Trucks

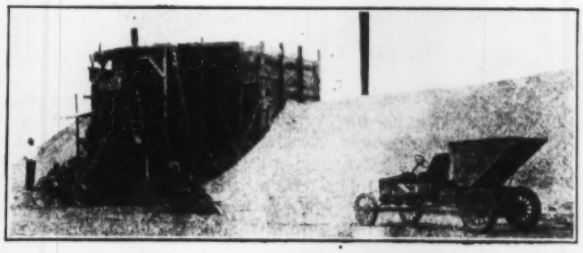
Pneumatic-tired trucks are essential where speed is an important factor in delivery and where it is necessary to do considerable hauling over the subgrade. Pneumatic tires will usually reduce the load on the subgrade to less than 125 lb. per square inch. This pressure, though frequently applied, does not seriously injure or displace a prepared subgrade having average soil conditions. It is practically impossible to deliver materials over earth roads with trucks when the roads are muddy or during rainy periods. However, the road may be materially improved, permitting the truck to be used practically the entire construction season, if it is constantly maintained by the use of the road drag and given an application of ½ gal. of oil per square yard of surface early in the construction season.

The light pneumatic-tired truck may also be used for the delivery of proportioned batches of aggregate direct to the paving mixer on the road being improved. There are now on the market many types of batch boxes and dump bodies that permit the batches to be dumped directly into the skip of the paving mixer.

Transportation is one of the most important factors in the economical construction of roads. This part of plant operation, therefore, should be given much study. The transportation cost should be estimated per ton-mile and should take into consideration the effect on the cost of operation of the remainder of the construction plant. Hauling costs vary from 20 to 40 cents per ton-mile. A saving, therefore, of a few cents per ton-mile may in a season's work amount to several thousand dollars. The actual hauling costs may be exceedingly low, yet if the delivery affects the maximum output of the remainder of the plant, the inefficiency of the plant should naturally be charged against the transportation cost.

Plant Costs and Improvements

The plant investment of the road contractor of today is entirely too great for the work that is accomplished during a single construction season or for the work done from one particular installation. It is not uncommon to see from $60,000 to $100,000 worth of equipment to build less than ten miles of highway. It is evident that this will show from $2,500 to $3,000 which must be charged off for equipment against every mile of road built. It is doubtful whether there is any other construction in which there is so much depreciation and interest on plant investment to be charged off on so small an amount of work. It would seem desirable, therefore, that the mechanical engineer, equipment designer and contractor should spend more time in the design



TRUCK HAULAGE OF WET BATCH FROM CENTRAL MIXING PLANT

of road construction plant in order to insure a greater output with less initial investment.

Many of our road-building machines are being made larger, more cumbersome and more expensive each year. The fact that road building machinery is subjected to more severe use than perhaps any other machinery used in construction has induced the manufacturer to add weight to his equipment each year to insure more rigid construction. The writer believes that the concrete paving mixer can be completely redesigned and a machine produced that will be much smaller in size, will mix more concrete and be less cumbersome. Mixer manufacturers have continued to improve the design of their paving mixers by following the same principles of mixing that have been in use for many years. It seems absurd that we must have a concrete paver costing $8,000 to $12,000 and weighing from 10 to 15 tons that will lay less than 2 miles of 18-ft. concrete road in 30 days. It seems absurd also that we should still be using a mixer that requires 60 sec. of time for mixing when it should be possible that the same amount of mixing by some mechanical means can be done in less than 15 sec. If such a machine could be produced, a one-bag paver would turn out as much concrete as our present four-bag paver. The present paver is also designed so that the mixing is concealed from the view of the operator; this absolutely prevents a uniform consistency which is essential in securing a good concrete.

If the mixer designer can produce a smaller machine having a greater output per hour of operation and have it so designed that the consistency of the concrete produced can be controlled by the operator instead of by some un-

satisfactory mechanical means, the results will be a wonderful aid to the road-building industry.

It also seems possible that a very material improvement can be made in railroad equipment. Practically all road contractors now unload aggregates from open-top cars by means of clam-shells. This method is not always the most economical but the contractor is forced to use it as he cannot secure hopper bottom cars. On account of the large volume of road materials that must be delivered by railroad cars, it seems possible that some type of car could be designed that would permit of more rapid unloading by more economical methods. If this is not done, it is hoped at least that open-top car manufacturers will improve the design of their cars and make them so that they can be more easily unloaded with clam-shell equipment. Not only would improvement in the design of open-top cars aid the individual unloading the car but the railroad company would add to the life of the equipment.

Deficiencies of Existing Cars

Many open-top cars are now designed with projecting angles, rivets, bolts, braces, timbers, etc., that serve chiefly to interfere with the efficient operation of the clam shell. It is difficult to understand why railroad cars could not be designed so that the interior of the car would be perfectly smooth. In fact the writer believes that it would be practicable and economical for all open-top cars to be built with a fillet having a radius of about 18 in. in the bottom angle at the ends of the car. The curved bottom angles would permit the cars to be emptied more rapidly and economically either with hand shovels or by clam shells.

Further investigation should also be made of the use of open-top removable batch boxes for railroad transportation of materials. While the substitution of standardized batch boxes for open-top cars would be a radical departure from present equipment, it is evident that the average construction plant could be designed to handle the transfer of boxes with considerable more economy than it now handles the loose materials.

Prevention of Water Hammer in Long Railway Force Main

By J. L. Campbell
Chief Engineer, El Paso & Southwestern System, El Paso, Texas

ONE operating district of the El Paso & Southwestern R.R. is supplied with water by a pipe line 140 miles long. On one section of this line the water is lifted through a distance of 37 miles to an elevation of 821 ft. by two pumping stations, one at the foot and the other half way up the hill. The pumps are Nordberg double-acting piston pumps.

Water hammer on the pumping main was prevented by a steel cylinder mounted in a horizontal position over and connected to the main outside the pump house. The cylinders are 5 ft. in diameter and 15 ft. long, designed for 300-lb. pressure, with glass gages on the cylinders and a pressure gage mounted on the pumping main immediately beyond the tee connection to the main. The pumps have a normal capacity of 1,000,000 gal. per day at 50 r.p.m. and a maximum pressure of 300 lb.

The upper half of the cylinders is kept full of air under the pumping pressure by automatic air-charging devices attached to the water end of the pumps and actuated by the working of the pumps. The vertical fluctuation of the water in the glass gages usually lies within ½ in. and the pressure gages indicate a variation of pressure less than 2 lb. Considering the length of the water column in the main and the high pressure the prevention of water hammer by this method is very complete.

Water-Closet Flush Tanks and the Water-Waste Problem

By Albert O. True
Hydraulic and Sanitary Engineer, Rensselaer, N. Y

WHAT is the safe minimum amount of water discharge from the common house flush tank? The writer estimates the sanitary flushing water of our larger cities as 12 to 20 per cent of the total water consumption.

Many are familiar with the accomplishments of the Construction Division, U. S. Army, in successfully limiting the per capita water consumption in the cantonments to 55 gal. per day. George W. Fuller, in discussing the admirable paper by Col. Dabney H. Maury, describing the water supply of the camps and cantonments, called attention to the expedient of bending down the floats in flush tanks for restricting the charge of flushing water (*Proceedings*, Am. Soc. C. E., Vol. XLV, No. 6). The writer, during his service as utilities officer in several cantonments, observed the effectiveness of this simple method. The discharge valves in some makes of tanks are designed to permit of regulation of the amount of flushing water.

Effect of Design on Volume of Water

A few years ago it was the writer's practice, as sanitary engineer, New York State Department of Architecture, in specifying water-closet flush tanks, to require a discharge of not less than 5 gal. of water per flush, and for flushing valves not less than 4 gal. At that time these details were largely a matter of custom, the important feature being to insure a copious flush. A few gallons more or less on the safe side did not seem a serious matter at the cost of water then prevailing.

My observations of flushing requirements for sanitary fixtures at the army cantonments indicate that an appreciable saving of water can be effected by reducing the volume of flush without danger of producing unsanitary conditions in the plumbing fixtures or in the sewerage system if the latter is well designed. The amount of reduction of flushing water which can be safely made will depend in each case on the type of water closet and arrangement of flush tank, and should be determined beyond any reasonable doubt by competent observation.

The writer has made experiments with the washdown siphon closet bowl. This fixture was almost universally installed in the army cantonments. It is the common house closet very largely used in civil communities having modern plumbing. The bowl is cleared by plain siphonic action of the flush. Its external characteristics are a circular water surface in the bowl and a "hump" protruding from the front of the bowl due to the outlet leg of the trap. These closets were operated for a period of observation of two months, using as little as 2½ gal. per flush. Flush tanks were of the "low-down" type, discharging directly into the closet through a short length of 2-in. flush pipe. "High up" tanks can be used with all types of water closets and require no more water than low-down tanks. Probably they can be operated with less water, as the flush is delivered under a head about 5.5 ft. greater than is the case in low-down tanks.

The writer roughly estimates that in the more modern houses of average communities 75 per cent of the

water closets are of the wash-down siphon type mentioned above. Most of the remaining 25 per cent will probably be of the siphon jet type—found in large and expensive residences, hotels, hospitals and institutional and governmental buildings. It can be recognized by its smooth "vase like" front, large oval water surface in bowl of about 90 sq.in. and bulbous, wavy curved back resulting from the tortuous outlet leg of the trap. The bowl is cleared by siphonic action, which is accelerated by a water jet impinging into the inlet leg of the trap. The tortuous passage of the outlet leg of the trap tends to fill the bore of the outlet, thus lending additional strength to the siphon action.

The writer has no experimental data on the minimum flush for the siphon jet closet or any closet using the water jet (some makers have a wash-down siphon bowl with water jet). It is known that they will operate safely with 4 gal. of water. Owing to the larger water content of the trap passages and bowl of the siphon-jet fixture, and its more powerful siphon action, it is likely it cannot be operated with less than 3½ gal. of flushing charge without endangering the water seal, unless the tank is provided with a generous "afterfill" attachment.

The latter device is simply a small pipe which discharges a part of the water (about 2 or 3 quarts) from the ball-cock valve into the closet bowl after the action in the bowl trap has ceased. It is commonly integral with the ball-cock equipment and discharges into the overflow standpipe.

Old Style Systems

All types of water closets other than those mentioned above will be found principally in old buildings having old-style plumbing systems. Some special types will b found in prisons and institutions. Most all the old-style fixtures are of the following four types: the wash-down, washout, down-flush and hopper closets. All are variations in the adaption of a bowl to an "S" trap either integral with or separate from the fixture. They are flushed almost always by high-up tanks, by displacement of the contents of the bowl and trap. It is probable that their water consumption could be cut in half with safety.

Data are not available on which to base positive figures as to possible saving in flushing water. The following illustration will therefore be considered a "desk estimate" awaiting revision or rejection: It is estimated that flush tanks average 20 flushes per fixture per day. Allowing an average of one water closet per family of five, flushing water at 5 gal. per flush, the daily water consumption in closets alone is 100 gal. per day per family.

In a city of 100,000 the flushing water from these fixtures would approximate 2,000,000 gal. per day. A saving of 40 gal. per water closet per day seems conservative at this time. This gives a total estimated saving for the above-named community of 800,000 gal. per day. At 7c. per 1,000 gal. this would result in a gross saving of $56 per day or $20,400 a year. Allowing $10,000 for expenses the first year and $6,000 for each succeeding year to effect and maintain this saving, there would result an annual net saving of about $9,000 per annum, assuming that there were always 25 per cent of the fixtures which needed attention, as would probably be shown by an inspection.

Sliding Car Stop for Yard Tracks

AS A SUBSTITUTE for usual fixed bumping posts at ends of yard tracks and industry tracks, some railways are using a sliding stop which is expected to check cars efficiently but without causing damage to the car or its contents. This device, shown in the accompanying views, consists of a pair of steel castings which rest on the rails, being held in place by flanges and secured by clamps fitting around the rail heads.

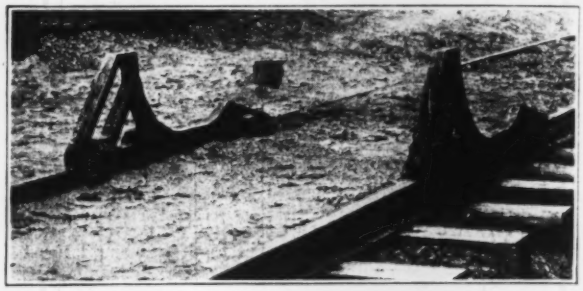


FIG. 1. CAR STOP ON YARD TRACK—SHOES IN PLACE

In ordinary practice the shoes are set 10 to 30 ft. from the rail end, but where longer travel is desired special splice bars are used to enable the clamps to pass the rail joints. Although the track is shortened normally by 10 to 30 ft., its full length can be utilized when necessary by pushing the car and shoes to the end blocks. When a car engages the stop, it is checked by the incline which carries the wheels into the shoes, along which they travel before striking the rear portions of the shoes, which are shaped to fit the wheels, as shown.

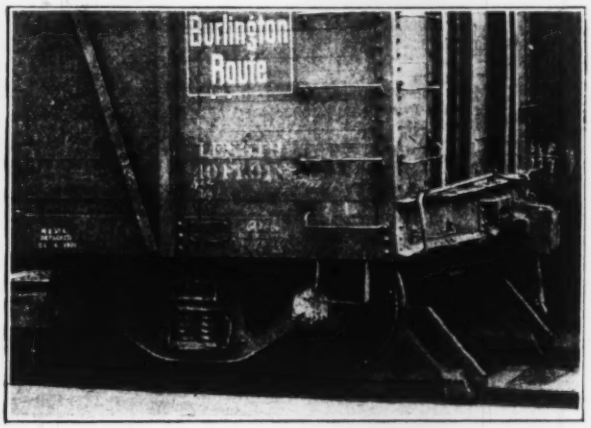


FIG. 2. CAR TRUCK IN SLIDING STOP—HALTED BY SHOES

In the design illustrated, only the two end wheels are engaged, but for tracks in continual service or having a down grade to the stub end the shoes are made longer, so that when the outer wheels reach the end of the shoe the inner wheels are resting on the incline.

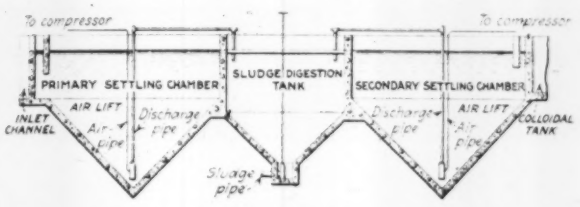
When a car is pulled off the stop, the small front projections cause the shoes to move with it until they reach their normal position, where they are stopped by striking the splice bars, the wheels then riding over the projections and returning to the rails. In tests, two 50-ft. loaded coal cars run against the stop at 8 m.p.h. moved it 30 ft. Another car at 5 m.p.h. moved it only 4 ft. further. This device is manufactured by the Friction Car Stop Co., Cleveland, Ohio.

Air-Lift Removal of Sludge from Sewage Tanks

By W. G. Kirchoffer
Madison, Wis.

EXPERIMENTS on the removal of sludge by air-lift pumps, made by the writer in connection with an investigation of the sewage works of Madison, Wis., showed advantages for this method as compared with the ordinary gravity method.

This Madison plant consisted of settling tanks with separate sludge digestion, followed by colloidal tanks, contact dosing chambers and sprinkling filters. The tank portion is divided into five units, each consisting of a primary and secondary settling tank, sludge digestion tank and a colloidal tank (see *Engineering News-Record*, Sept. 11, 1919, p. 510). Unit No. 3 was divided into two half-units. Usually 2, 2½ or 3 units are in service at a



AIR LIFTS IN SEWAGE TANKS

time, depending upon the season of the year or the ideas of the superintendent. The air-lift tests were applied to unit No. 3-B.

The air pumps were made of 1½ and 2-in. pipes with foot pieces of 4-in. and nozzle of ¾-in. pipe. Some trouble was experienced with clogging due to threads, strings and waste which accumulated in the bottoms of the tanks in large balls. Had the pumps been made of larger pipe with larger flaring foot pieces and no nozzles, this trouble would have been largely avoided. The arrangement is shown in the accompanying drawing. Efficiency in air consumption and power required were matters left for future consideration. The plant consisted of a 4 x 6-in. vertical air compressor and a 4-hp. gasoline engine. Better results might have been expected with the plant operated by an electric motor or automatically from a large air storage tank.

Chemical Analysis—In the raw sewage or primary settling tank the average of several determinations for relative stability by the methylene blue test showed no stability by either the air-lift or the old gravity process. In the secondary and colloidal tanks, the air-lift showed 11 and 30 per cent respectively, the gravity process showing zero and 21 per cent. The average results were 7 and 14 for the two processes respectively.

Tests for oxygen consumed were consistently in favor of the air lift for all the tanks and filters. The very few tests for free and abluminoid ammonia, nitrites and nitrates showed as good results for the air-lift as for the old process. The results on total, dissolved and suspended solids were more or less erratic due to fluctuations in the character of the sewage and disturbances in the inlet channel. Tests showed no percentage of removal in the primary settling tank and only 2.7 per cent in the secondary by the old process, but 15.4 per cent in the secondary tanks by the air-lift.

The best results for removal of suspended solids at the colloidal tanks were 63½ per cent by the old process and 93½ per cent by the air-lift. The contact filters showed no reduction in suspended solids by either process. The average removal of suspended solids by the entire plant was 48 per cent for the old process and 53.5 per cent for the air-lift, the maximum results being 82 and 100 per cent respectively.

Sedimentation Tests

The beneficial results of the air-lift removal of sludge are illustrated by the records of sedimentation tests made by James Mackin, superintendent of the plant. A 1-gal. sample was collected at 7 a.m., 1 p.m. and 4 p.m. each day of raw sewage from the inlet channel and tank effluent from the collection channel at the end of the colloidal tanks. These samples were placed in conical galvanized-iron receptacles with glass graduates attached to the small ends. After standing for three hours the deposits were recorded in cubic centimeters, as indicated on the glass graduate. When clean tanks were first put into operation, the old or gravity process of removal would show results as good as the air-lift process, but as the tanks began to foul up with septic sludge the effluent would begin to show an increase in the settleable solids until such times as the tanks would be put out of commission, and clean tanks put in use in their stead.

After my investigation Mr. Mackin continued to operate the plant, but pumping the sludge once daily. He also continued to take samples of effluent for sedimentation tests. On Nov. 1 units No. 1, 2, 3-A and 3-B were in operation. The sediment in 1-gal. samples was 1 c.c. for No. 1 and No. 2. Samples from 3-B (air-lift test) showed no sediment. By the end of the month both No. 1 and 2 showed 4 c.c. per gallon sample. The effluent from 3-B was 0 to 0.5 until the middle of the month and from 0.5 to 1.0 c.c. to the end of the month.

On Dec. 3 units Nos. 4 and 5 were put in operation, 3-B with air-lift sludge removal being continued. Clogging of the air-lift pumps was experienced from Dec. 10 to 28, when the tanks were emptied and large balls of rags, lint and strings were found at the entrance to the foot piece. After this cleaning the tests showed not to exceed 1 c.c. During this period the colloidal tank of unit 3-B was not cleaned out and it is evident that septic action was taking place, as it was noted in all of the colloidal tanks that septic action began 20 to 40 days after starting a unit. These tanks had flat bottoms and were not easily cleaned without dumping. In a plant where such tanks could have septic sludge removed readily or where no such tanks were used it is probable that the sediment in gallon samples could be held to zero or nearly so.

From experience covering a period of several months it was concluded that the use of air-lift pumps is an effective method of sludge removal where tanks for separate sludge digestion are provided.

Providence Resumes Chemical Precipitation

Treatment of the sewage of Providence, R. I., by chemical precipitation with lime was resumed the latter part of April. The practice was discontinued in September, 1919, because it was impossible to obtain lime or towage to convey the sludge to sea for dumping. All sewage reaching the precipitation plant was disinfected with hypochlorite during this period, but through a large part of 1920 most of the Providence sewage was discharged directly into the river through storm overflows without disinfection, owing to a break in the intercepting sewer.

Motor Truck Transport of Freight by European Railroads

RAILWAYS in France and England operate a store-door delivery service for parcels (or express) and freight, for which service motor transport systems are used extensively and special means have been introduced for increasing the economic efficiency of such systems by reducing time lost in loading and unloading.

Eight-Wheel Tractor-Trailer Unit—Motor vehicles are superseding horse-drawn vehicles in the service of the Paris & Orleans Ry., at Paris, France, according to a paper in the *Revue Generale des Chemins de Fer* by Mr. de Laland, superintendent of commercial service of this railway. Horse wagons are still used for districts near the station but light 1- and 1½-ton motor trucks are used for the long trips, in order to utilize the speed capacity which is their great advantage.

For regularity of the station work it is necessary to clear the freight platforms rapidly and it has been the practice to place horse wagons at the platform in the evening and leave them to be loaded at night. This arrangement prevented placing the motor trucks early in the morning for prompt loading, and the trucks could not be left all night as it was necessary to take them to the garage for the regular overhauling. A test with demountable decks or floors for the trucks did not prove

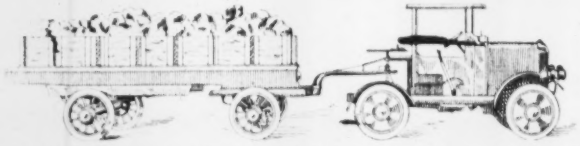


FIG. 1. TRACTOR-TRAILER UNIT OF PARIS & ORLEANS RY. (FRANCE)

satisfactory, as they could not be removed from the station platform when loaded and it was difficult to shift them to the truck frames.

A tractor-trailer system, Fig. 1, proved to be a satisfactory solution of the difficulty, using a 1½-ton four-wheel tractor having a 15-hp. four-cylinder engine and pneumatic tires. The trailer has a flat floor with removable stakes and side boards, and its wheels have solid rubber tires. It is designed for 5 tons but can carry 8 tons. To the swiveling frame of the front axle is attached the pole or draw bar, with automatic coupler engaging a nut on a vertical screw at the rear of the tractor. The driver can operate this nut from his seat, raising or lowering it in order to vary the load carried by the rear or driving wheels and thus vary the adhesion of the tractor.

This tractor-trailer unit or train can turn easily in a 16-ft. street. A switching tractor at the station places the empty trailers at the freight platforms as required and removes the loaded trailers to a yard where the regular tractors couple up to them. The service requires about three trainers to each tractor, the equipment at the Ivry freight station at Paris being 20 tractors with 50 trailers.

Six-Wheel Tractor-Trailer Unit—The Great Western Ry., England, has introduced a system in which a four-wheel tractor supports the front end of a two-wheel trailer, the unit being capable of hauling a 7-ton load at the legal speed limit of 20 m.p.h., according to a paper read by Mr. Conradi before the British Institution of Mechanical Engineers. The trailers are parked in the station yard, the forward end of the trailer being supported by a pair of hinged legs, but with this arrangement the trailer cannot be moved to and from the platform without attaching it to a tractor. Mr. Conradi suggested that by fitting wheels to the supporting legs the trailers could be moved by a team, and it may be noted that such a wheeled support is used for a tractor-trailer system now in operation at St. Louis, Mo.

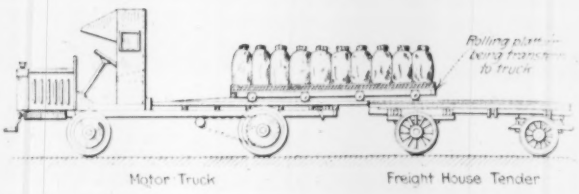


FIG. 2. MOTOR TRUCK WITH ROLLING DEMOUNTABLE FLOOR; MIDLAND RY. (ENGLAND)

Motor Truck with Demountable Floor—For the Midland Ry., England, a system of portable rolling floors for motor trucks was devised by Mr. Conradi, thus avoiding the necessity of installing overhead cranes to handle these floors, as at the freight stations of the Lancashire & Yorkshire Ry. The system on the latter road is somewhat similar to that employed for l.c.l. freight transfer at Cincinnati, O. (see *Engineering News-Record*, March 11, 1920, p. 508), except that closed bodies as containers instead of movable floors are used at Cincinnati. For the Midland Ry. service a number of old horse-drawn wagons were converted into station "tenders" by having the floors fitted with rails for the small wheels or rollers of the portable floors. Tenders with portable floors mounted on them are placed at the freight house for loading and are then removed to the station yard by horses. An empty motor truck backs up to the tender, and the portable floor with its load is rolled onto the truck frame and secured, as shown in Fig. 2.

A suggested modification is to erect fixed platforms with rails, on which the loaded portable floors can be placed if no trucks are ready, thus enabling the tender to be moved to the station for another load. At warehouses or industries tenders or fixed platforms may be provided for prompt transfer of loads to and from the motor trucks.

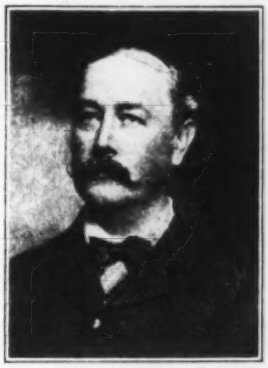
Preventing Mortar Stains on Masonry

Brown stains on limestone masonry arising (presumably) from action of the mortar are being studied at the Bureau of Standards in Washington, where two methods of preventing this staining are under investigation. The first is the use of a colorless waterproofing material on the limestone at the contact face of the mortar, the action of which is to prevent the passage of water through the mortar and into the stone in such a way as to carry the staining material with it. Preliminary tests indicate that most of the staining is prevented by this means. The second method consists of applying a removable porous coating on the exposed face of the limestone wall. The stains then come through the coating, form on its outer surface and later on are removed when the coating is removed, while when forming directly on the stone surface they are difficult to remove because the staining material is insoluble. The method is expected to be of some value as most of the stains form during the erection of the masonry.

Completes Forty-Eight Years' Service As City Engineer

Charles E. Bolling, Who Entered Engineering Department of Richmond, Va., in 1873, Becomes Consultant to City

IN FEBRUARY, 1921, Charles E. Bolling became consulting engineer for the Department of Public Service of the city of Richmond, Va., after forty-eight years' continuous service in the city engineering department, the last thirteen of which were as city engineer. Practically the whole municipal development is included in these years. In 1873 Richmond was a discouraged, fire-torn city of 54,000, hardly yet recovered from the ravages of war and the inertia of reconstruction. Today it is a prosperous civic community of 175,000, well built and admirably equipped with every engineering and sanitary necessity. Mr. Bolling has had no small part in this growth. While like most engineers he has not reaped great pecuniary reward, in his own words, he has now "the satisfaction that work, hard work, and fidelity to trust may bring an engineer so long a public servant."



CHARLES E. BOLLING

Mr. Bolling entered the service of the city of Richmond Feb. 15, 1873, as assistant to the city engineer, Capt. Charles H. Dimmock, who died only the next month to be succeeded by Col. W. E. Cutshaw, the city engineer for the next thirty-four years. The city engineer at that time had charge of all street and sewer construction, maintenance and repairs, grounds and parks, bridges and the James River harbor improvement. He was further required to make all surveys for the other municipal departments and supervise plans and specifications for all public buildings of every kind. The city was only slowly recovering from the destruction and loss occasioned by the Civil War and the almost total destruction by fire in April, 1865, of its manufacturing and mercantile districts. During the reconstruction period from 1865 to '70 no municipal improvements of any kind had been made. There were no plans for future development. Many of the records had been destroyed, the city's finances were little or nothing, and its credit was practically nil. The field for the future was a broad one.

Colonel Cutshaw with only three assistant engineers devoted the following three decades to the task of making Richmond a city, and in this work he was ably assited by Mr. Bolling. From February, 1873, to July, 1885, Mr. Bolling was on surveys, plans, street paving, sewer construction, public parks, reservoir plans, and public plans. From 1874 to 1876 he was assistant engineer in charge of the building of a reservoir near the city for additional water-supply and the laying of all supply mains and other appurtenances connected therewith. After completion of this reservoir he was put in charge of all city construction work on streets and sewers and on surveys for additional water-power pumps at a new location above the city on the James River.

In July, 1885, he was elected by the city council to be superintendent of the city water-works, which included also the duties of engineer of the water department, formerly performed by the city engineer. In this capacity he worked for twenty-three years, during which time there were designed and constructed large sedimentation and coagulating basins, located between the canal and river, one mile above the pump works, and the enlargement of the distribution system with installation of practically 100 per cent metering was carried to successful completion.

After the death of Colonel Cutshaw in November, 1907, Mr. Bolling was elected by the city council as city engineer and entered upon the discharge of these duties in January, 1908. From that date to January, 1919, for each term of two years he was re-elected city engineer. In 1919 by reason of a charter change in the city he was elected director of public works, embracing the position of city engineer. In February, 1921, he was succeeded as director of public works by Allen J. Saville, nominated by the mayor for this office and elected by the council. Mr. Saville appointed Mr. Bolling consulting engineer for the department of public works, which position he now holds.

Boston Sliding Scale Gas Rate Standard Raised by Commission

In granting an increase in gas rates to the Boston Consolidated Gas Co. the Massachusetts Department of Public Utilities reviewed in some detail what has become known as the Boston sliding gas scale. Provision for this scale, with a standard or base price of 90c. per 1,000 cu.ft. and a standard dividend of 7 per cent, was made by the Massachusetts Legislature in 1906. Before passing to the commission's summary of its decision, it may be noted that the increase in gas rates allowed by the commission up to $1.40 per 1,000 cu.ft. near the end of the year was preceded by temporary increases of the standard price to $1.10 on Mar. 5, 1920, and to $1.35 on July 23. This action was taken under a clause in the act of 1906 that provided for jurisdiction by the commission provided that there should be no deviation from the standard price of 90c. for ten years and none thereafter unless a change become necessary to correct inequities arising from substantial changes in the costs of making and distributing gas. The syllabus in this opinion, as given in *Public Utilities Reports*, March 17, 1921 (Rochester, N. Y.), follows:

1. The Massachusetts "sliding scale" act expressly suspended the jurisdiction of the commission over the price of gas to be charged to the consumer, reductions in price depending solely on the desire of the stockholders for greater dividends.

2. The principle of the Massachusetts "sliding scale" act that decreased costs and increased profits due to skillful and wise management shall be shared by the stockholders and the public rather than wholly taken by either, is essentially sound, but conversion of the theory into a fixed rule, expressed by the interrelation of a standard price and standard dividend, is necessarily artificial, and conditions must be stable and a considerable period elapse to make it an effective regulator of the selling price.

3. In the midst of unstable and unprecedented operating costs, a standard cost of gas does not exist, and a standard price is an anomaly, and, therefore, the standard required by law to be fixed should be a temporary rather than a permanent one.

4. The standard price of gas to be fixed by the Boston Consolidated Gas Co. under the Massachusetts "sliding scale" act was placed at $1.40 a thousand cubic feet.

Remote-Control Electric Haulage in Quarry Service

Two Layouts for Overburden and Rock—Economy Over Steam Service—Man in Tower Controls Car Motors and Brakes

ELECTRIC traction by a remote control system, in which car movements are governed by an operator in an elevated tower, is the method adopted by the Bessemer Limestone & Cement Co., Youngstown, Ohio, in removing the overburden from a new quarry. Shale and top soil, having a thickness of 35 to 55 ft., are excavated by a steam shovel having a 3½-yd. dipper and giving a daily output of 1,000 to 1,500 cu.yd. A similar system for handling the quarry rock has been in service for over two years, and the accompanying plan shows the two layouts for stripping the site and for handling quarry stone.

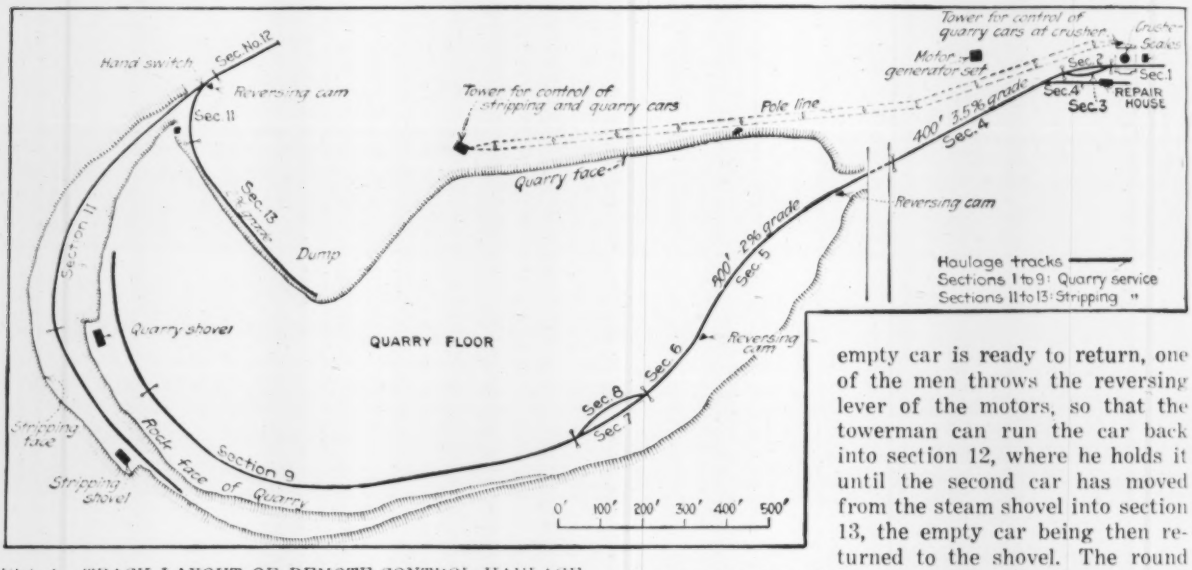


FIG. 1. TRACK LAYOUT OF REMOTE-CONTROL HAULAGE SYSTEMS AT QUARRY

All tracks are of standard gage, with 60-lb. rails having bonded joints and cross bonds at 200-ft. intervals. Insulated joints divide the track of the stripping layout into four sections, with separate electric supply to each. A 45-lb. third rail is carried by supports on the middle of the ties. The three sections marked 11, 12 and 13 are under the control of the towerman. The end section, at the stripping face, is controlled by the steam shovel operator. This section is short and is shifted as the shovel advances.

Handling Overburden.—Two 20-yd. side-dump cars are used for the stripping work and are operated on the shuttle system. The cars have a 30-hp. motor on each truck and are fitted with solenoid electric brakes. Current of 220 to 240 volts is used for the motors, but for the brakes 110-volt current is applied to the solenoids through electric switches. When the car at the shovel is loaded, the shovel operator throws a control switch and admits current to the track section, causing the car to move into section 11, where it is under control of the tower man. The car continues into the switchback section 12, where a cam at the side of the track operates a lever on the car, reversing the motors. The switchman opens the switch admitting the car into section 13, where the towerman stops it at any desired point by shutting off the current and applying the brakes. For the more permanent layout of the quarry service the switches and reversing cams are under the control of the towerman.

In section 13 the track is on the edge of a spoil bank 40 ft. high and is shifted as the dumping progresses. When a man on the dump releases a latch the weight of the load tilts the car body, the empty body returning to position by gravity and being latched automatically. About six men are employed at the dump to level the material and shift the track. At times they have to dump the car by hand or with jacks. There is no automatic reversing cam on the dump track, but when the empty car is ready to return, one of the men throws the reversing lever of the motors, so that the towerman can run the car back into section 12, where he holds it until the second car has moved from the steam shovel into section 13, the empty car being then returned to the shovel. The round trip averages 8 to 10 minutes, with a running speed of 15 m.p.h.

With two cars, a towerman and a switchman, about 1,000 to 1,500 cu.yd. are handled daily, as compared with 800 cu.yd. with the former equipment of two steam locomotives operating trains of six 4-yd. cars on tracks of 38-in. gage. Two enginemen and two brakemen were required, while the electric haulage system requires only two men. There is also less time lost at the shovel, and as track has to be kept in better condition for the large cars the car repair work is proportionately less. The number of men used on the dump depends on the handling of track and varies with the amount of dumping space available. Ordinarily the shifting of the dump track occupies one day each week.

Handling Quarry Stone.—In quarry service, for removing the rock to the crusher plant, three cars of 10-cu.yd. capacity are in operation. No switchback is included in the quarry layout, but there are two passing sidings, the cars being operated on the shuttle system. This part of the track layout comprises nine sections under the control of the same towerman who controls the stripping movements, these sections including the two sidings and a repair track. A second towerman at the crusher house spots and dumps the cars. The end section in the quarry, which is generally short, is under control of the shovel operator, as in the stripping work. Grades of 2 and 3½ per cent lead from the quarry floor to the crusher plant.

A loaded car started by the shovel operator moves into section 9, where its control is in the hands of the towerman, who stops it usually at the first siding (on sections 8 or 7) to allow an empty car to pass. The car is held by applying the brakes through the solenoid and electric switch and then cutting off current from the section in which the car stands. The empty car proceeds through section 9 to the short section at the steam shovel, at which point it comes under the control of the shovel operator; meanwhile the loaded car is run through three sections to the second siding, where it passes an empty car just coming from the crusher. Finally the loaded car is run into the crusher house, where it is spotted by the towerman by means of the brakes and is dumped by means of a remote-control hoist also operated by the towerman. A reversing cam at the crusher automatically throws the reversing control on the car as it arrives at the dumping hopper, so that the empty car can be started back to the quarry.

Both the stripping and the quarrying work are in full view of the main towerman, only hand signals being required from the switchman and dump foreman of the stripping layout. If the towerman should fail to see the car start from the shovel it would simply drift into the next section and come to a stop. No trouble is experienced in dark or foggy weather and at night the work is illuminated by flood lights. Electric current is supplied by a local power company.

Electric and Steam Operation.—In 2½ years' experience with quarry haulage this remote control system has been found satisfactory both as to service and cost, as compared with light locomotives and cars. It is considered by the quarry company that there is some saving in power, but that the main saving lies in the fact that the movements of the cars are all under control of one man, stationed in a sheltered position. This results in fewer delays and more regular operation, with consequent greater output or material handled. Shuttle operation is used for both the stripping service and the quarry service, but continuous loop operation on a similar haulage system, with spur tracks at the shovels, has been used at another large quarry, as described in *Engineering News* Oct. 21, 1909, p. 421.

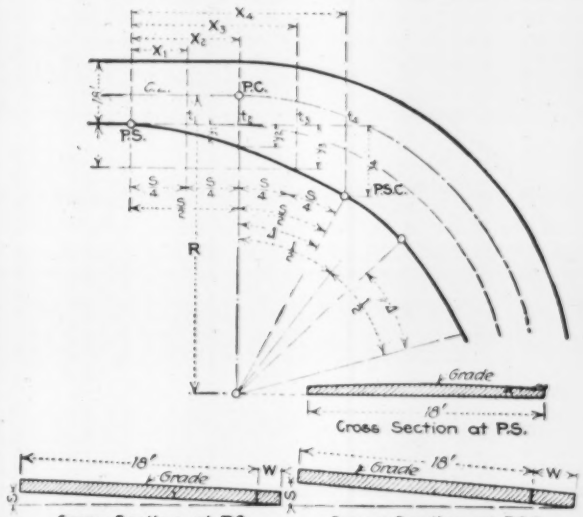
During the last three months of 1920, when the electric haulage system for the stripping had come into full operation and was working on an economical basis, the cost per cubic yard of material excavated and dumped was 40 per cent that of the former cost of steam operation.

The electric haulage system is that of the Woodford Engineering Co., Chicago, which supplied and installed the electrical equipment. The introduction of this system was decided upon by F. R. Kanengeiser, vice-president and general manager of the Bessemer Limestone & Cement Co., and the operation is under the direction of J. A. Johnson, superintendent of the company.

Pennsylvania Practice in Widening Highway Curves

HIGHWAY curves are widened and superelevated, in the standard practice of the Pennsylvania Highway Department, by the use of the transition spiral and one-slope roadway, as indicated by the accompanying diagram and tabulation of offsets and superelevations.

In applying the table, the engineer selects such a central angle delta as will give at least an arc of widened roadway one-third in length. For example: Given I = 84°; R = 200 ft., and delta = ⅓ I = 28°. Interpolating from the table: One-half length of spiral equals 70 ft., and the offset from tangent T at PS equals 0 ft.; at T_1 (35 ft. beyond PS) equals 0.2 ft.; at T_2 (or $P.C.$ of circular curve) equals 1.5 ft.; at T_3 (from tangent projected) equals 6 ft., and at T_4 equals 16 ft.



CURVE DIAGRAM, PENNSYLVANIA HIGHWAYS

OFFSETS AND SUPERELEVATIONS FOR WIDENING HIGHWAY CURVES

Radius of Cl. of Roadway	Total Offset	Half Length of Spiral for Various Angles Angles from 0 to 15°	Angles of 15° and Over	Offset in Feet from Tangent of Edge of Widened Road — Point T_1 X_1	Y_1	Point T_2 X_2	Y_2	Point T_3 X_3	Y_3	Point T_4 X_4	Y_4	Super-Elevation of P. C. S. and P. S. C.
50′	6 5′	..	15′	7 4′	0 9′	14 7′	3 3′	21 5′	6 2′	28 3′	9 4′	12¼″
60	6 0	..	20	10 0	0 4	19 6	3 0	28 9	6 7	38 2	10 5	12
80	5 0	..	20	10 0	0 3	19 8	2 5	29 4	5 2	39 0	7 8	11¼
100	4 5	..	30	15 0	0 3	29 9	2 3	44 5	5 3	58 9	9 6	11½
120	4 0	..	40	20 0	0 3	39 9	2 0	59 6	5 5	78 7	11 6	11
140	4 0	..	40	20 0	0 3	39 9	2 0	59 6	5 5	79 0	10 4	11
160	3 5	..	40	20 0	0 2	39 9	1 8	59 9	4 7	79 3	9 2	10¾
180	3 5	..	50	25 0	0 2	50 0	1 8	74 7	5 0	99 0	11 0	10¾
200	3 0	35	..	17 5	0 2	34 9	1 5	52 3	3 5	69 6	6 3	10¾
200	3 0	..	70	35 0	0 2	70 0	1 5	104 7	6 0	138 2	16 0	10¾
220	3 0	35	..	17 5	0 2	34 9	1 5	52 3	3 4	69 6	5 9	10¾
220	3 0	..	70	35 0	0 2	70 0	1 5	104 7	5 6	138 5	4 6	10¾
240	2 5	40	..	20 0	0 2	40 0	1 3	59 9	3 3	79 6	6 2	10¾
240	2 5	..	80	40 0	0 2	80 0	1 3	119 7	6 0	158 2	16 7	10¾
260	2 5	45	..	22 5	0 2	45 0	1 3	67 4	3 3	89 6	6 6	10¾
260	2 5	..	90	45 0	0 2	90 0	1 3	134 7	6 4	177 9	19 0	10¾
280	2 5	50	..	25 0	0 2	50 0	1 3	75 0	3 3	99 7	7 2	10¾
280	2 5	..	100	50 0	0 2	100 0	1 3	149 7	6 8	197 6	21 0	10¾
300	2 0	50	..	25 0	0 1	50 0	1 0	74 9	3 0	99 4	8 0	10
300	2 0	..	100	50 0	0 1	100 0	1 0	149 7	6 5	196 5	24 0	10

In superelevating, start is made at *PS* with the standard crown. From this point the crown is gradually changed into a one-slope section until at the *PC*, one-half the superelevation, as shown in column five of the table, is obtained. The superelevation is then gradually increased until the maximum superelevation as shown in column five is reached at the *PSC*, this superelevation being held until the *PSC* is reached. Beyond the *PSC* the superelevation is diminished by one-half at the *PC*, from which point the one-slope section is gradually changed to the crown section.

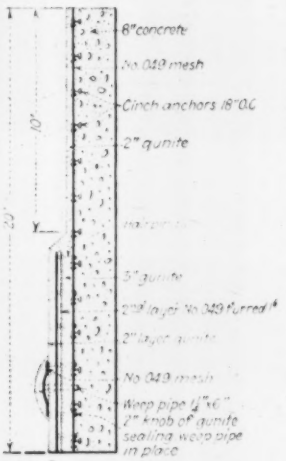
It is the practice to make the thickness of the one-slope slab uniform and equal to the average thickness of the standard 18-ft., crowned section.

Reservoir Waterproofed by Gunite Interlining

Seepage Through Porous and Cracked Walls Entirely Stopped—Construction Methods Described in Detail

By Barclay A. Greene
Pratt-Thompson Construction Co., Kansas City, Mo.

A CEMENT gun method of waterproofing, which is possible of frequent use, was successfully employed last season to stop ground water seepage into a small reservoir of the Mount Vernon, Iowa, water supply. Porous spots and cracks had developed generally in the reservoir side walls until, under an unbalanced head, the inflow was 100,000 gal. in 24 hours. This inflow was completely stopped by a 1:3 mortar lining constructed as shown by the accompanying sketch.



GUNITE INTERLINING FOR CIRCULAR RESERVOIR

Leakage had developed gradually. The reservoir, a circular tank 40 ft. in diameter and 20 ft. high, was underground, with a 6-ft. covering. The bottom 5 ft. was in solid rock, but the shell was 8 in. thick from bottom to top and the floor and roof were also 8 in. thick of 1:2:4 concrete. At the time of construction, eight years ago, the concrete was a little porous and the leakage small—just a moderate seepage through reasonably sound material. The seepage, however, increased with the age of the reservoir until the walls had become porous and cracked and the inflow had reached the volume stated. This inflow was through the shell and largely within a zone from 1 ft. to 10 ft. from the floor. The maximum head was 17.85 ft.,

From a light scaffolding over the entire interior of the tank, the walls were sounded and all loose material removed with picks. Then, starting at the top, a layer of American Steel & Wire Co.'s triangular mesh, No. 049, was placed and anchored securely by means of ½-in. two-stage cinch-anchors, and ½-in. x 3-in. bolts. Each layer of mesh had a side lap of 4 in. and an end lap of 8 in., and all laps were securely wired with No. 14 black annealed wire; the ties were 8 in. apart on the seams.

After the mesh was placed, the cement gun was used as a sand-blast machine and the concrete was thoroughly sand-blasted, leaving a clean unaffected surface, and cleaning all rust from the mesh. Starting at the top and working down, the 1:3 mixture of sand and cement was then applied 2 in. thick, without any waterproofing compound whatever.

As the work neared the bottom 10 ft., where the seepage was greatest, a 3-in. layer was applied. Within the bottom 6 ft., 26 weep pipes were installed, varying from ¾ to 1¼ in. in diameter and held temporarily in place by a small amount of oakum around the pipe, placed well back from the surface of the concrete. To seal the weep pipes in place, a mixture of one part cement, two parts sand, and two parts gypsum was used and deposited with the gun. This was the only place where any mixture other than 1:3 sand and cement was used. At this bottom section of 6 ft. it was also necessary to place an additional 2 in. of lining, with another layer of mesh, making a total of 5 in.

The second layer of mesh was anchored to the first layer by hair-pin ties; a tie was made of No. 14 wire in the shape of a hair-pin 6 in. long, and was twisted around the first layer of mesh and allowed to protrude 3 in. through the first 3-in. layer of mortar. After this 3 in. had set, the second layer of mesh was placed, and anchored to the No. 14 wires, securely twisted and drawn taut, but furred 1 in. away from the first layer by means of pre-cast concrete blocks. The lining was brought down to the bottom with no fastening to the bottom.

There was no seepage whatever through the floor and the floor concrete was in good condition so the bottom was not touched. This method concentrated the seepage entirely to the flow from the 26 weep pipes. These were capped alternately, and gunite, with a layer of mesh, was applied until the weep pipes were entirely covered by a knob of mortar. The mesh placed over these knobs was anchored in the same manner as the second layer of mesh, by means of hair-pin ties.

The work was performed by the Pratt-Thompson Construction Co., Kansas City, Mo.

Traffic in 1920 Through the Sault Canals

An increase of 16 per cent in freight traffic and 20 per cent in passenger traffic for the season of 1920, as compared with the season of 1919, passing through the American and Canadian canals at the Sault Ste. Marie, Michigan and Ontario, is indicated in the statistical report on 1920 operations, prepared under the direction of Lt.-Col. E. M. Markham, Corps of Engineers, U. S. Army. The total freight traffic of both canals was 798,282,496 tons during 1920, showing an increase of 11,046,954 tons over 1919. The total number of passengers was 68,451, or an increase of 11,459. The traffic through the American canal was 97 per cent of the total freight and 37 per cent of the total number of passengers carried. Compared with the season of 1919 there was an increase of 20 per cent in freight and 58 per cent in passenger traffic. Traffic through the Canadian canal was 3 per cent of the total freight and 63 per cent of total passengers carried. Compared with the previous season there was a decrease in freight traffic of 40 per cent and an increase in passenger traffic of 6 per cent. The American canal was opened April 19 and closed Dec. 26, 1920, and the Canadian canal was opened April 23 and closed Dec. 23, 1920.

The Engineer in Foreign Trade

Technical and Business Qualifications Demanded of Federal Representatives for Special Investigators

By R. S. Mac Elwee
Director, U. S. Bureau of Foreign and Domestic Commerce, Washington, D. C.

THERE is undoubtedly a great field for the properly trained engineer in the foreign-trade service of the United States. In private business and in Government activity there is a constant demand for engineers who possess, in addition, commercial qualifications. The marketing of highly technical products abroad requires engineering training as a background, with the proper commercial and language study superimposed upon the engineering foundation.

In selling harvesting machinery, gas engines, and tractors, for example, this lack of a technical training has been keenly felt by many of the men who have not had it, and some of them have tried to familiarize themselves as much as possible with some of the fundamental engineering principles through reading, courses with correspondence schools, and the like. The sales manager for an elevator company, selling, putting up, and registering elevators abroad, realized so keenly the basic necessity for a sound electro-engineering training that a rule was adopted making this a prerequisite in the employment of salesmen. This work, of course, is only typical of many lines of engineering—civil, mechanical, electrical, chemical, and industrial.

Technically Trained Men Desired

As to the requirements of the Government, there may, of course, be other branches of the federal service that need engineers who have, also, a training in foreign affairs and languages, but in the present discussion I wish to speak especially of the Bureau of Foreign and Domestic Commerce. This bureau has had and now has attachés and trade commissioners who are professional engineers. The new policy has been to assign an engineering trade commissioner as assistant to the commercial attaché at those posts where engineering matters are of prime importance. At present, Major Brady, mechanical engineer, is assigned to assist the commercial attaché at Buenos Aires. Following the armistice, he was assigned to the commercial attaché in France. We have Frank Rhea, railroad engineer, assigned to the commercial attaché at Peking. If we are to have thoroughgoing reports of value on technical subjects, the men who write them must be technical men and must have had not only proper technical education, but also considerable professional experience. The Bureau of Foreign and Domestic Commerce sends abroad traveling trade commissioners to make extended investigations in special lines, and in specific surveys of this character it has, for example, employed mining engineers.

Effective Work by Engineers

The peculiar availability of such men for certain of the trade-commissioner positions is illustrated by several investigations that have been made in the past or are now in process. Particularly conspicuous has been the work of Paul Page Whitham, who spent three years in China and tropical Asia studying transportation matters and has written numerous confidential and other reports. Two large reports, "The Port of Shanghai" and "The Port of Manila," the bureau hopes to publish this year if it has sufficient funds. Usually, such able men who serve the bureau for a time enter private employment sooner or later at salaries very much larger than those the bureau is able to pay. Mr. Whitham has returned to China in a private capacity.

Although the number of engineers of various types that enter the service of the Department of Commerce abroad is necessarily limited, the number going into foreign trade is large enough to offer our universities a problem in engineering education.

The foreign commerce of the United States is particularly in need of those men who are competent engineers and who have, at the same time, the personality and business training in foreign affairs to enable them to go abroad and compete with British, German, French, Belgian, and other nations for large and lucrative contracts that are being let by foreign firms, cities, and central governments. This is a problem deserving the closest consideration by the engineering profession.

Reinforcing a Bridge Corroded by Locomotive Gases

BROADWAY in Cleveland crosses the tracks of the New York, Chicago & St. Louis Ry. (Nickel Plate) on a steel deck-plate-girder bridge built in 1888. On account of extensive corrosion of the floor system of this structure in recent years, especially over two drill tracks, the bridge was slated for early replacement. Corrosion had attacked especially the top flanges of the 38-in. plate-girder floor beams, which were found to be greatly reduced in area, and some holes had developed even in the web below the top flanges. The corrosion was almost as bad in the sidewalk brackets outside the girders as in the floor beams between the girders, although the girders themselves showed little injury. Financial conditions, however, delayed the renewal of the bridge, and it became necessary to reinforce the structure in order to maintain it in service.

New stringers had been put in some years ago, and as the main girders, 66 in. deep, were not seriously affected, the floor beams and sidewalk brackets were the principal items to be dealt with, and this only in the three panels over the drill tracks. It was decided that the floor beams were not so much weakened but that they could be left in place and counted upon for partial duty if supplementary floor beams were put in to take part of the load and be available for full service in case of failure of the old beams. This scheme was carried out, using 20-in. I-beams taken out of another structure. An I-beam was placed transversely midway between the old floor beams, being riveted to the main girders after bringing it up to bearing against the stringers. The cantilevered sidewalk brackets were dealt with in the same way. Additional stiffeners and kneebraces were placed on the main girders at the connections of the new floorbeams.

According to George H. Tinker, bridge engineer of the Nickel Plate, who carried out this reinforcement, two cast-iron sewer and water pipes suspended five to ten feet below the bridge floor do not appear to have been injured by the locomotive gases. The iron hanger rods supporting these pipes are attacked, however, and must be replaced from time to time.

LETTERS TO THE EDITOR

If you have ideas that would interest engineers and contractors we shall be glad to give them space here. We urge, however, that you be brief so that a wide range of subjects may be covered in the available space.—The Editor.

Turbine Specific Speeds

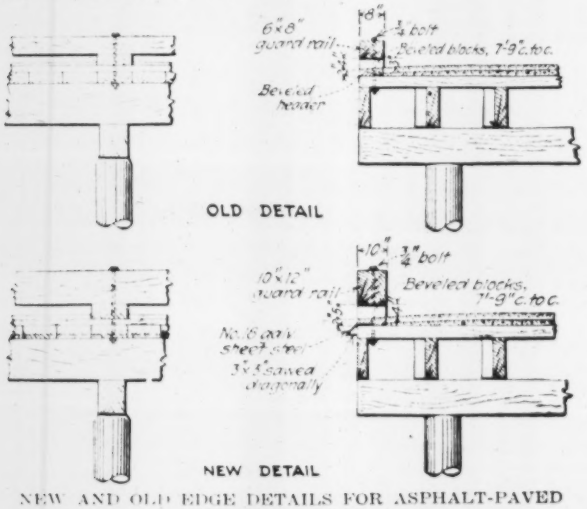
Sir—In connection with the article by E. A. VanDeusen in *Engineering News-Record*, May 12, 1921, p. 806, on specific speeds of turbines, progress in turbine design may be noted. The specific speed of a Francis runner varies between 10 and 100 and, in the usual stock turbines, between about 25 and 85. It is reported, however, that a Bohemian engineer, Viktor Kaplan, has designed one to run at 360, and to develop high efficiency. If tests substantiate this claim the utilization of low heads will be greatly simplified; it may even lead to the development of tidal power, a problem that has received the attention of so many British engineers.

LYNN PERRY.

Easton, Pa., May 20.

Edge Waterproofing for Asphalted Bridge Floors

Sir—Your issue of Dec. 3, 1920, contains on p. 1279 an article describing the Wisconsin Highway Commission's method of covering plank decks on highway bridges with bituminous wearing surfaces. Local experience with timber trestles which have been paved with sheet asphalt extends over a period of about twelve years. The shortcomings of the early designs have developed during this time and have also suggested several improvements. In view of our experience, I feel it desirable to call the attention of your readers to a point wherein the Wisconsin method requires additional features to give good results if untreated planking is used for decking.



NEW AND OLD EDGE DETAILS FOR ASPHALT-PAVED TRESTLE—SEATTLE

We find that where water from the pavement is permitted to crawl back under the planking, assisted by winds, capillary attraction or slope, dry rot sets in. The first indication of this is a break in the pavement, at first in only a few places, but always near the edge of the roadway. By degrees the damage becomes more general. Where heavy loads have broken through the pavement, the repair gangs find the planking badly decayed.

To prevent similar destruction, later structures have been provided with a metal drip, as shown, which conducts the harmful water away. In order further to protect the deck in case water should find a way between the header and paving, we paint the planking when laid with two coats of creosote oil. This painting is confined to a strip 1 wide along both margins of the roadway. With this add protection, we feel that the life of our structures will lengthened considerably.

W. H. TIEDEMAN,
Seattle, Wash., April 14. Assistant City Engineer

Hudson Vehicle Tunnel Ventilation

Sir—In your issue of March 31, p. 562, there is an art under the caption "Hudson River Vehicle Tunnel C tracts To Be Ready May 15," and in the following iss of April 7, p. 602, there appears a statement of the ma mum amount of free air per minute required to give ad quate ventilation when the tunnel is being operated a full capacity, with motor vehicles only.

The cross-sectional design of the tunnel, as shown o the plans of the commission, gives a pressure duct are of about 61 sq.ft., with an exhaust duct area of about 7 sq.ft. With these data at hand it is possible to make a approximate estimate of horsepower required to operat the ventilating system that has been outlined in the vario reports on the subject, but as yet no such estimate ha appeared in print. The results of such an investigation are herewith appended, which the writer believes are o public interest, as the act of the New York Legislature creating this enterprise specified that the tolls and rental shall pay the estimated cost of administration, maintenance and operation, and in addition will pay within 20 years the amortized cost of construction.

The distance between pier-head ventilating shafts center to center of the river section appears on published plans to be 3,800 ft., with the distance between New Jersey shafts 2,000 ft., and between New York shafts 1,100 ft. The amount of air required per tube from each pier-head shaft toward the river is 378,843 cu.ft. per minute, giving an initial intake-duct velocity of 6,210 ft. per minute. In the north tube, downgrade, there are two stretches, each 1,100 ft. in length, each stretch requiring 133,037 cu.ft. per minute, initial duct velocity 2,181 ft. per minute. Upgrade, two stretches 1,000 ft. long, each requiring 324,058 cu.ft. per minute, initial duct velocity 5,312 ft. per minute, and one stretch 500 ft. long, to portal, requiring 162,029 cu.ft. per minute, duct velocity 2,656 ft. per minute. In the south tube, downgrade, one stretch from portal to shaft, 500 ft. long, requiring 64,655 cu.ft. per minute, duct velocity 1,060 ft. per minute, and two stretches 1,000 ft. long each requiring 129,310 cu.ft. per minute, initial velocity 2,120 ft. per minute. Upgrade, if pier-head shaft is used in both directions, two stretches, each 550 ft. long, each requiring 175,434 cu.ft. per minute, duct velocity 2,876 ft. per minute, and one stretch 1,100 ft. long to exit portal, requiring 350,868 cu.ft. per minute, duct velocity 5,752 ft. per minute.

In determining the static pressure caused by duct friction allowance must be made for the flattened form of duct. The intake or pressure duct has a frictional resistance due to its form, equivalent to a circular duct 75 in. in diameter, through which air is passng at the same velocity.

As data on duct friction is principally founded on galvanized iron walls some modification might have to be made in the case of concrete enclosures, but if necessary some other lining could be introduced within the concrete. It is proposed to throttle the discharges into the tunnel so as to give equal distribution of air along each duct line. This arrangement, while giving equal ventilation along the line, increases the static pressure. Some allowance must be made for the formation of eddies and air pockets by which a certain amount of pure air will bypass to the exhaust duct, without performing its full duty of dilution.

This adopted system of ventilation requires practically double the horsepower of those in ordinary practice on account of the exhaust. While exhaust duct has a larger area it may be assumed that the power to operate it will be about the same as to operate the intake. In order to make the system flexible and to proportion it to traffic conditions, a battery of say four fan units will be required on each duct line, as only about 50 per cent reduction is the standard practice on a motor-driven fan unit. Such an

arrangement of multiple units, of course, increases the horsepower.

A rough calculation on the above basis gives a total of 8,000 hp. for the river section, 1,881 hp. for the New Jersey section, and 1,446 hp. for the New York section, or a total of 11,327 hp. Assuming that a rate of 2c. per hp. could be obtained, the power cost of operating at maximum capacity would be $226.54 per hour, $5,436.96 per day and $1,984,490.40 per year.

In order to arrive at some estimate of what proportion of this maximum ventilation will be required per annum, in operating the tunnel, four different years have been considered—the year of opening, five years after opening, ten years after opening, and fifteen years after opening.

In a forecast of tunnel traffic given on p. 7 of the 1920 report of the commission, the maximum hourly traffic is given as 1,350, or 675 for each tunnel, or one-third of the tunnel capacity, at time of opening. In five years, 1,050 for each tunnel, or one-half capacity. In ten years, 1,550, or four-fifths capacity, and in fifteen years, full capacity at maximum.

No study, however, is presented as to the estimated traffic distribution during the twenty-hour hours. From a comparison of the Hudson ferry traffic charts the following traffic distribution has been deduced, covering a 24-hr. period:

6 hours 15% of maximum traffic	6 hours 60% of maximum traffic
6 hours 30% of maximum traffic	6 hours 100% of maximum traffic

As it would be impracticable to follow all the traffic fluctuations with ventilation adjustment, the above is assumed to be the rate of plant operation during the different periods.

At the opening of the tunnel, with a maximum of one-third tunnel capacity, we arrive at a ventilating cost of $25,000 per annum for normal traffic conditions. Five years after opening, with a maximum of one-half tunnel capacity, we get a cost of $85,000 per annum. Ten years after opening, with a maximum of four-fifths tunnel capacity, we get a cost of $330,000 per annum. Fifteen years after opening, with maximum of tunnel capacity, we get a cost of $725,000 per annum.

In the above annual costs no allowance is made for possible blocks in the tunnel, as no data are at hand as to probable frequency of their occurrence and the average duration of the resulting traffic jam. Both these factors of frequency and duration will greatly increase as the amount of maximum traffic approaches tunnel capacity and will add greatly to ventilation costs.

Some data for forecasting these costs might be obtained from a study of traffic operations over the East River bridges, and deducing therefrom some percentage of frequency of traffic blocks as maximum traffic approaches bridge capacity. The duration of resulting traffic jams, however, will be much greater in the tunnel than on the bridges, since the trouble point will be on the upgrade. With the bridges this is on the approach, and traffic may be diverted; while in the tunnel this is at the outlet, and the whole length of tunnel behind becomes congested. To the above costs per annum, therefore, a sum must be added to cover the expense of traffic blocks, and the amount so added will increase very rapidly with each year of increased traffic.

On p. 71 of the commission's 1920 report, a financial statement is given showing how the tunnel cost is to be amortized, but on p. 69 the estimated cost of power for lighting, pumping and ventilation is given at $31,000 per annum at time of opening, and $301,000 per annum when tunnel is operated at full capacity. It would appear, therefore, that those figures should be amended to conform to these lately published ventilation requirements.

As the horsepower varies inversely as the cube of the duct area it would seem advisable to considerably increase their capacity, especially in the river section. The same object could be accomplished on the approaches by adding another ventilating shaft on the upgrade land portions. An alternative would be to provide for future duct enlargement, as the ventilating costs will mount very rapidly toward the maximum after the ten-year period is past. Still another alternative would be to limit the traffic to a lower maximum than tunnel capacity, if this can be done without interfering with the requirements of the New York act.

WALTON I. AIMS,
New York City, May 7. Civil Engineer.

[Proof of the foregoing communication from Mr. Aims was submitted to Clifford M. Holland, chief engineer of the New York-New Jersey tunnel commissions, whose reply follows—Editor].

Sir—Referring to the communication from Walton I. Aims proof of which has been submitted to me for consideration, it appears that the main point raised by him is that from an approximate estimate of the horse-power required to operate the ventilating system, he concludes that the amortization figures published in the commissions' 1920 report should be amended.

Mr. Aims' analysis appears to be correct in principle, but his calculations are based upon incorrect data, as determined from the recent experiments performed on the large scale model of the tunnel duct at the University of Illinois under the direction of Prof. Arthur C. Willard. This work has been done under an agreement between the tunnel commissions, the U. S. Bureau of Mines, and the university to obtain the coefficient of friction for the flow of air in concrete ducts and the horsepower required to ventilate the tunnel. The results of these exhaustive experiments show that the horsepower differs less than 10 per cent from the horsepower forming the basis of the figures published in the commissions' 1920 report. It is expected that this data will be published shortly in a bulletin by the engineering experiment station of the University of Illinois.

CLIFFORD M. HOLLAND.
New York, May 20.

Notes on the Suez Canal and on Indian Public Works

Sir—On my way East I have recently passed through the Suez Canal and learned there from the resident engineer some facts regarding its maintenance that may interest your readers.

The Suez Canal is 160 km. long. During and since the war the work of deepening and enlarging has gone on steadily, and the depth of 12 m. at present aimed at has been completed for a distance of 130 km., leaving 30 km. which is 10.5 km. deep. This portion of least depth is toward the Suez end, where there is a tide of 1 to 1.8 m. so that it may be said that the full depth exists throughout at certain stages of the tide. There is practically no tide at the Mediterranean end.

The minimum width at bottom is 45 m. The ordinary width of 60 to 75 m. is increased to 100 to 110 m. at curves and special places. Much of the canal banks are now lined with stone wall to prevent washing, and this wall is set back at full standard width, leaving in places some dredging still to be done to complete the enlargement. The breakwater at Port Said has been extended so as to obviate much of the silting up of the entrance which formerly occurred. Generally the canal is in a forward and efficient state and there is practically 40 ft. of water available now.

The traffic before the war was about 20 million tons annually. It fell during the war to 13 to 14 millions and is now about 17 millions.

There is much public work being done in India and building operations are active. Many new projects are, however, delayed because of financial stringency and also awaiting the clearing of the political atmosphere, the prospects for the improvement of which seem better than they were. The British government has introduced far-reaching reforms giving the native people much more scope and control than they had before. A few native agitators are very noisy, but the mass of the people know nothing of democratic government and were quite content to have their affairs looked after and the country developed by the British, who on the whole did it honestly and well. The tales of the misrule of a down-trodden people are pure fabrication. It remains to be seen how the new regime will work out.

A. W. ROBINSON.
Singapore, April 10.

HINTS FOR THE CONTRACTOR

Gravity Plant With Drop Chute Pours Steel Building Floors

CONCRETE floors and concrete embedding the framework of a steel factory at Cleveland, O., was successfully placed with a boom-type gravity plant by hanging a vertical chute to a counterweight chute elevated to swing clear of the steel framework. In steel buildings, ordinarily, it is impracticable to chute by gravity plant directly into the forms because the steel frame interferes with swinging the inclined chutes. Therefore the common practice is to chute to a floor hopper and wheel the concrete from this hopper to the forms. In constructing an 80 x 300 ft. steel frame factory for the Cleveland Rubber Co., the gravity plant tower was built high enough to permit the boom and counterweight chutes to clear the steelwork and the concrete was dropped directly into place by a vertical chute extending down through the steel frame. This procedure is stated to have been economical compared with wheeling. The contractors are the United States Engineering Construction Co., of Cleveland, Ohio, with K. D. Cowan as superintendent in charge.

Bucket and Trolley Form Simple Means for Shaft Sinking

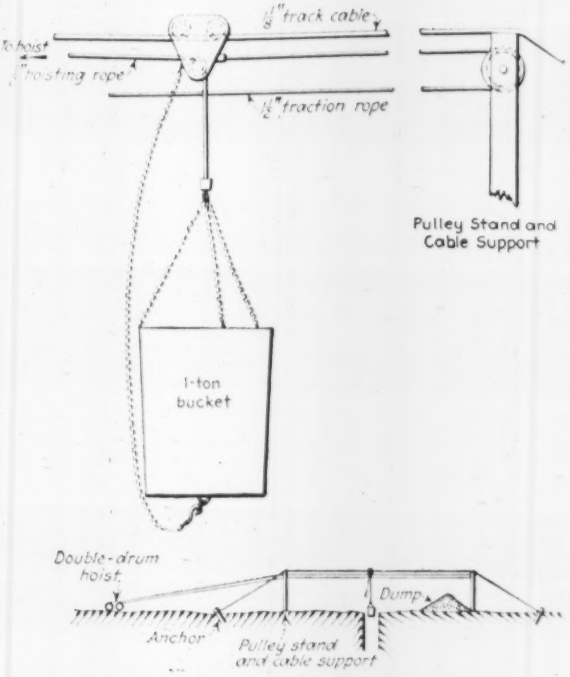
By B. G. Best
Civil and Mining Engineer, Ironwood, Michigan

THE arrangement shown in the accompanying sketch may be used in sinking a prospect or ventilation shaft when it is desired to minimize the expense of temporary equipment such as headframes, trestles, cars, etc., or when surface operating costs must be kept as low as possible.

As used in sinking a small shaft for a Michigan iron mine the equipment consisted of a 1¼-in. wire-rope track cable, passing over the mouth of the shaft and securely anchored at both ends; two timber supports for the track cable, which also serve as pulley stands; ½-in. wire hoisting rope and traction rope; three pulleys for ½-in. rope, two placed one above the other on the pulley stand nearest the hoist and the third in the farther stand; a trolley; a short length of chain attached to the trolley and having a hook at the lower end; a sinking bucket; and a double drum hoist.

The supports for the track cable were placed on a line passing through the center of the mouth of the shaft and the center line of the drum, at approximately equal distances on each side of the shaft, and far enough apart to provide sufficient room for the waste dump. The bucket was supported by three chains instead of the customary bail to reduce the danger of overturning while in motion and to allow the bucket to right itself after dumping. The hoisting rope ran from the drum over the upper pulley on the first support, through the trolley to the bucket. The traction rope ran from the drum over the lower pulley on the first support, around the pulley on the second stand, and back to the trolley where it was made fast.

In operation the bucket was hoisted high enough to allow the lander to fasten the hook of the trolley chain in a ring in the bottom of the bucket. The bucket was then pulled out to the dump by the traction rope, the hoisting rope being kept sufficiently taut to hold the bucket in an upright position. To dump the bucket the hoisting rope was paid out at a greater speed than that at which the traction rope was taken in. Taking in the hoisting rope while the traction rope was held fast righted the bucket, and when the traction rope was paid out the bucket was pulled back to the shaft. The



GENERAL ARRANGEMENT AND DETAILS OF BUCKET AND TROLLEY

brake on the traction rope drum was then set and the bucket lowered.

When the track cable may be inclined, with the lower end at the dump, stops may be placed on the track cable and the traction rope done away with.

The disadvantage of such an arrangement is the additional delay caused the shaft miners while the bucket is being drawn out to the dump and back to the shaft, but this slight disadvantage is more than compensated for by the reduced equipment and operating costs.

Taking the Curl Out of Large Drawings

By Ralph R. Randell
Federal Power Commission, Washington, D. C.

THE handling and working with tracings and other large sheets which have been rolled, is often rendered difficult by their tendency to curl. The curl is ordinarily lessened or eliminated by re-rolling tightly in the reverse direction. An easier method of removing is found by alternately heating and cooling the roll, the heating and cooling being done conveniently by placing the roll on a radiator or in the sun, and in a cool draft in the shade.

NEWS OF THE WEEK

New York, June 2, 1921

MacDonald Testifies Before Townsend Committee

Chief of Bureau of Public Roads States Principles Favored for Federal Aid Legislation

(Washington Correspondence)

While good arguments have been made for and against the Townsend bill in the hearings being conducted by the Senate committee on postoffices and post roads, it seems to be the general sentiment that the advocates of the Townsend measure have scored most convincingly. It may be stated, however, that no organized effort has been made by friends of the Dowell bill to impress the Townsend committee. It is evident, nevertheless, that Senator Townsend is interested in having all views on highway legislation made a part of the record which is being built up before his committee.

Gen. Pershing appeared before the committee and while he emphasized the importance of local roads, his testimony, taken as a whole, can not be regarded as a particularly strong endorsement of either of the plans now before Congress. It was clear that Gen. Pershing was not familiar with either of the bills and his observations were of the most general character.

TOWNSEND BILL OPPOSED

Thomas H. MacDonald, chief of the U. S. Bureau of Roads, was the most important recent witness to oppose the Townsend measure. He said, in part:

"A policy of self-determination is the policy which has been adopted by the Government in a large way. This to me is the big important question in this whole matter—that the efforts of the Federal Government should assist in developing matters primarily of local interest but which, in the aggregate, have a tremendous influence upon the national life. The form of the legislation has recognized the necessity of reconciling the conflicting claims of the advocates of state rights and of those in favor of centralization in matters which affect, first of all, the local and afterward the Nation as a whole.

"These are principles which I feel should be incorporated in new federal legislation:

"1. Adequate provision should be made for securing and retaining the services of men best qualified in highway engineering and administration. To do this it will be necessary to increase by a considerable margin the salaries now paid in the Federal organization. The salaries now paid are below the scale paid in many of the states.

(Continued on p. 966)

Vehicle Tunnel Wrangle Continues

At their joint meeting May 24 the New York and the New Jersey commissions charged with the administration of the Hudson River vehicular tunnel project failed to reach any agreement as to whether or not the board of consulting engineers, "dismissed" by the Jersey commission, is still legally in existence. No move was made to break the deadlock on the Jersey City street widening controversy, although "satisfactory progress" on the settlement negotiations was reported by Commissioner Shay. Three of the New Jersey commissioners, Messrs. Noyes, Barlow and Boettger, refused to join in the majority vote of the Jersey body approving salary vouchers for the members of New Jersey's "board of technical advisers," appointed to take the place of the board of consulting engineers which the Jersey commission claims to have abolished and which the New York commission insists is still in existence. At this writing the attorney-general of New York has rendered no opinion in the case and the delay in starting construction work at the New Jersey end of the tubes continues.

Licensing Controversy Referred to Am. Soc. C. E. Committee

At its meeting April 25 the board of direction of the American Society of Civil Engineers appointed a committee of five (R. L. Humphrey, chairman, Willard Beahan, Baxter L. Brown, Anson Marston and Francis Lee Stuart) to consider and report upon the matter of the practice of engineering by corporations and unrestricted partnerships.

The subject was introduced by a communication to the board by Col. W. J. Wilgus. After discussion the following resolution was offered by C. W. Hudson and seconded by George H. Pegram;

"Resolved: That it is the sense of the board of direction of the American Society of Civil Engineers that the granting of licenses to practise engineering and surveying should be limited to qualified professional engineers and surveyors and associations composed solely of qualified professional engineers and surveyors, and be it

"Further Resolved: That a copy of this resolution be forwarded by the secretary to the Hon. Nathan L. Miller, Governor of the State of New York."

Following discussion a substitute motion, offered by I. W. McConnell, referring the whole matter to a committee of five to be appointed by the chair and to report at a future meeting was carried by a vote of 9 to 7.

Conference Discusses Highway Traffic Regulation

Trend Toward Automatic Control Evident—Two-Lane Widths Sufficient Says Johnson

Highway traffic regulation from the point of view of state and city authorities and the public was the subject of a one-day conference, May 23, held under the auspices of Yale University at New Haven, Conn. The meeting, organized by Prof. Charles J. Tilden, who is on leave of absence from the university in order to serve as director of the federal committee on highway and highway transport education at Washington, D. C., included addresses by William P. Eno, traffic specialist, of Washington, D. C.; Commissioner Charles J. Bennett of the Connecticut Highway Department, Dean A. N. Johnson, University of Maryland; Harriet E. Beard, of the Detroit Department of Education, and Police Commissioner James W. Inches of Detroit. One of the main objects of the conference was to stimulate public interest in the regulation of highway traffic in order to secure more rational and effective legislation, a higher degree of public safety and a wise expenditure of road building funds.

CENTRAL BUREAU NEEDED

The conference brought out, among other things, the need for a centralized bureau of information on highway transport and traffic regulation, the administration of traffic control by specialists instead of aldermen, police commissioners and other unqualified city officials, a more intimate knowledge of the subject by the public, and traffic census statistics which may be used as a basis for the economic planning of state highway systems. In the city traffic problem the scientific control of vehicular movement and the education of the public are the important factors, while the state problem, as set forth by Commissioner Bennett and Dean Johnson, involves the proper location and width of highways, restrictions as to the weight, size and speed of motor vehicles, and schedules of registration fees based on service rendered. The dominant note sounded at the conference was the need for a new kind of thinking by state and municipal officials charged with the administration of highways and streets. It was frequently emphasized that today's demand is for an intensive study of the economics of highway transport rather than the details of highway construction and design.

In stating the basic principles which

should govern the regulation of traffic on city streets, Mr. Eno stressed the need for codes drafted by experts. Education of the public, beginning with the children in school, was insisted upon as a necessary feature of successful traffic regulation. The trend of development, according to Mr. Eno, is toward the automatic regulation of traffic by means of signs, semaphores, signal towers, and lines painted upon the pavement. He quoted figures showing that more than 50,000 deaths from traffic accidents during 1920 exceeded the total number of men in the American army killed in action during the war.

NEW YORK AND DETROIT TRAFFIC

Digressing from his prepared paper, Mr. Eno maintained that a vast improvement in handling traffic on Fifth Ave., New York City, could be effected by inaugurating a scheme of rotary traffic at all street intersections. He characterized as a failure the present scheme of controlling traffic on Fifth Ave. by signal towers, which, he said, were improperly located and had the effect of driving off the avenue all vehicles except the Fifth Ave. buses and the automobiles of shoppers. The present Fifth Ave. scheme, he stated, is uneconomical in that in the 1¼ miles between 34th and 57th Sts. as many as 120 policemen have been assigned to traffic duty. Mr. Eno's paper will be published in an early issue.

In describing the control of traffic at Detroit, Commissioner Inches endorsed the principle of automatic control by means of signs and signaling devices at frequent intervals. One of the most pressing problems of the present relates to the parking of vehicles on city streets. Eventually, Commissioner Inches believes, cities must embark on extensive programs of street widening or else must construct municipal garages, if the parking problem is to be solved. Detroit's traffic regulation system involves an extensive use of signs, towers, and other signaling devices, which Commissioner Inches explained in detail. He was followed by Miss Beard, who described how the public schools of Detroit are instructing the children in the elements of traffic control and public safety.

BASIS OF VEHICLE FEES

Commissioner Bennett, of Connecticut, whose paper is published in full on page 935 of this issue, asserted that traffic has become the most important factor in the administration of public funds for the development of highway systems. Making certain assumptions regarding the operating costs of motor trucks on dirt and on paved highways, he presented an argument for an increase in motor vehicle fees, based on the extra cost of service rendered to this agency of highway transport. Mr. Bennett made a strong plea for a centralized bureau of information on transportation and traffic subjects and for a bureau of research in this field.

The traffic census and its significance, by Dean Johnson, was the concluding paper of the conference. Using figures covering the total number of motor vehicles in the United States, the total road mileage, and making assumptions as to the percentages of the highway mileage carrying motor traffic and the range of operation of these vehicles, Dean Johnson reached a conclusion that 500 vehicles per mile per day represents the average traffic on state highway systems. As a result of observations on certain Maryland roads, curves were plotted showing the number of vehicles passing a given point at various speeds and spacings. The clearance between moving vehicles was found to vary as the square of the velocity. At a 15-mile per hour speed and a clearance between vehicles of 15 ft., the discharge of a single traffic lane is 2,640 vehicles per hour. Upon the assumptions made it was shown that at certain higher rates of speed fewer vehicles per hour passed a given point, due to lengthening the clearance distance between vehicles. Dean Johnson concluded that except in certain special cases state highway systems will not be called upon to carry, on the average, more than 500 vehicles per day throughout the year and that a highway paved for a width sufficient to accommodate two lanes of traffic will suffice for many years to come. Highway plans contemplating an extended system constructed for a greater width than required by two lanes of traffic are, in Dean Johnson's opinion, extravagant and without economic justification. Dean Johnson's paper and traffic diagrams will be published in an early issue.

New Basis for Motor Vehicle Fees in Minnesota

Under the terms of a constitutional amendment adopted at the general election last November, the Legislature of Minnesota has passed regulations for the levying and expenditure of automobile license funds. In lieu of all other taxes motor vehicles will be taxed yearly as follows: Two per cent of the list price at the factory, for the first three years of the life of a car; during the fourth and fifth years on 75 per cent, and thereafter on 50 per cent of the list price. The following minimums have been established: $12 for cars weighing less than 2,000 lb. and $15 for cars weighing more; for trucks, $15 under 2 tons capacity, $30 between 2 and 4 tons, $50 for over 4 tons.

All license funds will be expended for the construction and repair of a system of trunk highways under the direction of a one-man commission. Governor Preus has appointed C. M. Babcock to be commissioner. Mr. Babcock has appointed J. H. Mullen to be deputy commissioner and chief engineer. Both men held like positions under the old system and were largely responsible for bringing about the change in levying and expending motor-car taxes.

Federal Engineering Bureaus Get Deficiency Appropriations

Quite contrary to the usual practice the committee on appropriations of the House of Representatives has acceded to the request of the Secretary of Commerce and has allowed the full $250,000 requested for export industries. This fund is to be used principally in an effort to assist the twelve chief export industries—cotton and cotton goods, paper and paper products, leather and leather products, chemicals (including dyestuffs), heavy machinery and machine tools, electrical goods, automobiles and accessories, lumber and lumber products, metal products, vegetable oils, hardware, and jewelry and silver ware.

In addition, the committee approved the full amounts which Secretary Hoover asked for the Bureau of Standards, as follows: Testing structural materials, $50,000; industrial research, including elimination of waste, $100,000; standardization of equipment, $100,000.

May Resume Store-Door Delivery

Railroad representatives at a conference recently held in Baltimore under the auspices of the Federal Highway Council's transportation committee agreed to the fullest co-operation in re-establishing store-door delivery in that city. After store-door delivery of less-than-carload freight had been in effect for forty-seven years in Baltimore and Washington, it was abolished by order of the Interstate Commerce Commission in 1913 on the ground that it constituted discrimination.

At the Baltimore meeting, the Pennsylvania R.R., the Baltimore & Ohio R.R., and the Western Maryland Ry., and shippers of Baltimore were represented. A. E. Beck, traffic manager, Merchants and Manufacturers Association of Baltimore, was appointed chairman of the local committee to work out the details of the service.

To Hold Conference on Resources of Interior Waters

A conservation conference to consider river and lakes as means of food production has been called by Herbert Hoover, Secretary of Commerce, and will be held at Fairport, Iowa, on June 8 to 10. His announcement points out that there is a certain community of interest between small groups, such as fishermen and sanitary engineers, but that there has been no concert of effort to serve the public welfare. Four broad subjects compose the program: (1) Depletion of aquatic resources, with causes and remedies; (2) utilization of swamp and shore areas as fish and game preserves; (3) opportunities and need of research station; (4) plans for conserving the resources of interior waters. Local arrangements are in the hands of R. L. Barney, Director of Fisheries Biological Station, Fairport, Iowa, and J. E. Krouse, Davenport Pearl Button Co., Davenport, Iowa.

International Railway Body Acts on Pre-War Basis

Under the name of the International Railway Association, the International Railway Congress has been reorganized and has resumed its pre-war functions of exchange of questionnaires and reports between railroad managements in various nations, with headquarters at Brussels, Belgium. Since the beginning of the world war the activities of the association have been suspended, and following the armistice the assets were sequestered by the Belgian Government since they included funds of Central European States. The last session of the association, meeting then as the International Railway Congress, was held in Berne, Switzerland, in 1910. The next meeting will be held at Rome in April, 1922. The 1915 session was scheduled to take place in Berlin.

Following the first International Railway Congress held at Brussels in 1885, a permanent association was formed, the articles of which were agreed upon at the Milan Congress in 1887, and from that time the association held meetings regularly, at first every two, then every three, and latterly every five years. Various railroad subjects were assigned for study to "reporters" and the results submitted at the meetings and in the Bulletin of the association. The Bulletin also has contained original articles on technical railroad matters, including those of organization, and reprints of other articles appearing in various countries, as well as detailed accounts of actual work accomplished and in progress.

Association Sequestered

After the return of the Belgian Government to Brussels, the association was "sequestered" and its dissolution and liquidation ordered, following which the administrations of the railways and the members representing the association, from thirty-five countries, transferred their equities to a new organization to be known as the International Railway Association, to function along the same lines as the old International Railway Congress. Germany is not represented among the thirty-five countries participating, including those of Europe, North and South America, Asia, and the new states comprising the old Empire of Austria-Hungary. Russia is not at present represented in the association, and the shares of the administrations of the old Russian railways have been deposited with a bank "until such a time as the events which are now developing in that country terminate." The governments of all the countries to which the association extends have now maintained their adherence.

It is stated that the International Railway Association is now in a position of resuming its work of rendering the same services as before the war, including the issuance of the Bulletin and the international studies of "reporters."

Announcement of the present status of the association is contained in a statement by Mr. Colson, vice-president of the permanent commission of the association, issued May 10, 1921. L. Weissenbruch, 11 Rue de Louvain, Brussels, Belgium, is secretary of the association.

Caribou Plant of Great Western Power Co. Put in Service

The Caribou hydro-electric plant of the Great Western Power Co., located on the Feather River in California, was put in service May 6 in the presence of a large group of company officials and guests who went to the plant by special train. The plant is connected to the high tension network serving San Francisco and is notable for the size of the two impulse units constituting the initial installation, which have a capacity of 30,000 hp. each, and for the high tension of the transmission line, which is 165,000 volts. The plant is about 185 mi. from San Francisco.

Diehl Is A. A. A.'s New President

George C. Diehl, consulting engineer, of Buffalo, N. Y., and engineer of Erie County, was last week elected president of the American Automobile Association at the annual meeting of the board of directors in Washington, D. C. Mr. Diehl had served for years as chairman of the association's good roads board. He is a member of the American Society of Civil Engineers.

In his final report as chairman of the good roads board Mr. Diehl said:

"We are convinced that road building benefits all classes of citizens and all kinds of property and that all who share in these benefits should also share in the burdens. We believe that motorists should insist that construction expenses of State highway systems, or the fund needed to retire State highway bonds, should be paid for from general taxation, city property and country property alike, and that the motor vehicle revenues should be reserved principally for the maintenance of the main highways."

City Manager Appointed for Sacramento, Cal.

The City Commission of Sacramento, Cal., acting under the recently adopted new commission-manager charter, has appointed Clyde L. Seavey city manager at a salary of $10,000 a year, for an indefinite period. Mr. Seavey, who will take office on June 30, when the commission plan goes into full effect, has been a member of the California Board of Control since its creation in 1911, except that for the period of 1915-17 he was released to serve as chairman of the State Tax Commission. Earlier Mr. Seavey had been connected with the State Board of Examiners and still earlier he had been managing editor of the Pasadena *News*. Sacramento had a population of about 66,000 by the census of 1920.

Owens Leaves Lakewood Company

Roy G. Owens, vice-president in charge of sales of the Lakewood Engineering Co., of Cleveland, has tendered his resignation. He has been prominent in the affairs of the company since the consolidation of the Milwaukee Concrete Mixer Co. with it in 1917 and has represented the Lakewood organization in numerous important conferences touching the welfare of the construction industry. Mr. Owens has been a factor in the formation of many of the progressive policies for which the Lakewood company has been noted in the contractors' and power plant equipment fields.

ROY G. OWENS

Mr. Owens has been in the construction industry all his life, his first business experience being in general and builders' hardware lines. In 1910 he joined the sales force of the Texas Portland Cement Co. and, after a year with that organization, went with the Wiley Chute Co. of which he later became proprietor. This company manufactured concrete distributing apparatus and Mr. Owens' connection with it continued from 1912 to 1917. In 1916 he became general sales manager of the Milwaukee Concrete Mixer Co., at the same time directing the interests of his own organization. In 1917 came the consolidation of the Milwaukee company with the Lakewood Engineering Co., with Mr. Owens in charge of sales.

His chief work has been the building up of the Lakewood sales organization. One of the departures for which he was largely responsible was the establishment of a policy of selling its equipment through its own branch houses, instead of through agents, wherever the volume of business seemed to justify that method of distribution.

In addition to the work normally falling to a director of sales, Mr. Owens has taken a broad interest in all movements for progress in the construction industry. He was the originator of the "Buy Now" campaign which was conducted on a national scope during the slack period immediately following the war. He has worked with the United States Chamber of Commerce on various matters relating to construction activities, and has personally directed several extensive circular campaigns carried on by the Lakewood Engineering Co. in order to induce highway engineers to let their contracts early and highway contractors to ship materials in the late winter, when a plentiful supply of open-top equipment was available.

Mr. Owens' resignation will take effect shortly, but plans for his new connection have not matured to a point where they can be announced.

New York Port Authority Appoints Consulting Board

Announcement was made at a luncheon of the Merchants' Association of New York City, May 27, by E. H. Outerbridge, chairman of the Port of New York Authority of the appointment by that body, of a technical advisory board of three members to assist in formulating the final comprehensive plan for the Port of New York, which must be presented to the legislatures of the two states, under the terms of the port compact, before Jan. 1, 1922. The members of the new board are: Francis Lee Stuart, previously vice-president and chief engineer, Baltimore & Ohio R.R., Morris Sherrerd, consulting engineer, Newark, N. J., and Nelson P. Lewis, consulting engineer, New York City, for many years chief engineer of the Board of Estimate. At the same time announcement was made of appointment to the engineering staff of the commission of Major Elihu C. Church, transportation engineer, who served on the General Staff of the A. E. F. in France and has more recently been connected with the New York Chamber of Commerce, and H. C. Bixler, superintendent, Manhattan division, Pennsylvania R.R.

Mr. Outerbridge also announced that the Port Authority is organizing an advisory council to be drawn from about 100 commercial and civic organizations in the Port District, who will be invited to name representatives and alternates to confer with the commissioners from time to time on all important questions involved in the work, and who will be expected to report back to their respective organizations.

Townsend Bill Hearings

(Continued from p. 963)

"2. Provision should be made for the classification of federal-aid roads in each state under systems of like or equal importance. The states should retain the initiative in the selection of these roads but federal authority should be given to review the selection and require modifications based on certain principles to be incorporated in the law.

"3. Federal funds for construction should be met by state funds, proper time being allowed for the states to secure the necessary legislation and constitutional changes.

"4. Maintenance of roads built partially with federal aid should be provided for.

"5. The federal administration should be given authority to train men for the organization in a manner similar to that now followed in France. It should not be the object to give men the preliminary engineering and economic training, but to take graduates from the established institutions providing specialized courses. The whole matter of highway organization and administration is a matter of trained personnel."

Senator Townsend asked Mr. MacDonald if a commission of five men devoting all their time and study to this subject could administer the road work more efficiently than the present Bureau of Public Roads. To this Mr. MacDonald answered: "I think the question is entirely a matter of the men who are put in. I think a commission might be set up that would do better work. I also think a commission might be chosen that would do much poorer work. I really do not believe anyone can answer that question. Road selection is a matter of common honesty. If the road commissioners of a county will specify honestly the most important road within that county it will undoubtedly become a part of an interstate system of roads. I believe we ought to accept and build on the foundation already established in the states, but give the Federal authority the right to review and modify, but not give it original jurisdiction."

Chapin Favors Commission

Roy D. Chapin, president of the Hudson Motor Car Co., made one of the best witnesses who have appeared for the Townsend bill. Among other things, he said:

"I favor a commission because in our form of government it seems the most feasible and business-like form of administration. A commission properly set up would have power to handle the subject properly. It would be a clearing house for the states in all their operations. It would be able to conduct research work on a very large and broad scale. It would have a continuity of policy which is of very great importance. It would work for the greatest good of the Nation, partly because it would be more directly responsible to the people of the Nation than is a bureau or department. A commission must stand upon its own bottom. Everything it does goes directly to the people. A commission would bring to the problem an aggregation of brains representing different types of minds. You have engineering minds, business minds and scientific minds. I condemn the existing federal-aid law emphatically."

Senator Oddie, of Nevada, asked Gen. Pershing whether he considered the quick completion of coast to coast highways, which would serve military as well as civic purposes, a very important step in our military progress. To this Gen. Pershing replied: "That would, of course, be valuable but you have four or five railroad trunk lines running across the continent. That would serve for transcontinental purposes. If the military operations were conducted in any particular locality those coast to coast roads would be available and useful for military purposes."

C. R. Berry, assistant general freight agent of the Chicago, Great Western railroad, made the following observation in the course of his testimony: "In our section the railroads are not opposing the hard surfaced roads. They are encouraging them. We feel that it will build up the value of the land and improve the counties and the territory which the railroads serve."

G. S. Hoag, field secretary, Lincoln Highway Association, declared that he would favor taking all Federal aid money and applying it on interstate roads and withdrawing aid to counties and states for inter-county roads.

Engineering Societies

Calendar

Annual Meetings

AMERICAN WATER WORKS ASSOCIATION, New York; Convention, Cleveland, June 6-10.

NATIONAL FIRE PROTECTION ASSOCIATION, 87 Milk St., Boston. Annual meeting, San Francisco, June 14-15-16.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia. Annual meeting, Asbury Park, N. J., June 20-24.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh, Pittsburgh, Pa.; Annual Convention, New Haven, Conn., June 28-July 1.

Personal Notes

YU CHI MA, formerly with the division of sanitary engineering, New York State Department of Health, has resigned to accept a position as operator and chemist with the new water purification plant at West Palm Beach, Fla.

I. B. LANPHIER, formerly assistant highway engineer, Illinois Highway Department, is now with the division of timber mechanics of the U. S. Forest Products Laboratory, Madison, Wis.

A. R. MCGINNES, engineer with the U. S. Reclamation Service, has been appointed project manager of the Huntley Project, with headquarters at Ballantine, Mont.

FRED A. RHODES has been re-elected manager of operations, city engineer, and street superintendent of San Diego, Cal.

MAJOR MOTT SAWYER, builder of the Government spruce railroad in the Olympic Peninsula near Port Townsend, Wash., has been appointed superintendent of the Olympia division of the Chicago, Milwaukee & St. Paul Ry. with headquarters at Port Angeles.

LAWRENCE LYONS, of Brook, Ind., has been appointed director of the Indiana State Highway Department.

M. J. STINCHFIELD, JR., formerly construction engineer with the Koppers Co., Pittsburgh, Pa., manufacturers of coke and gas ovens, has been appointed assistant state engineer

of Indiana to be connected with the drainage, stream pollution and water power problems of the state.

THOMAS C. ATWOOD has been selected by the trustees building committee of the University of North Carolina as its executive agent in carrying out the building program authorized by the legislature recently. He has made a specialty of management-engineering for some years past and has been connected with the construction of the Yale Bowl, the Squantum destroyer plant for the Navy Department, the Sparrows Point and other shipyards for the Emergency Fleet Corporation and a large mill and housing project for the Durham Hosiery Mills.

LAFAYETTE HIGGINS, state sanitary engineer, Iowa State Board of Health, since 1908, has resigned to open a consulting office with his son, Lafayette Higgins, Jr. Mr. Higgins served the Board of Health on part time until 1913. From 1890 to 1896 he was professor of civil engineering at Drake University and for the two succeeding years was city engineer of Des Moines, Ia. He maintained a consulting office up to 1913. His son spent a year with the Chicago, Rock Island & Pacific Railway Co. and for the past year has been an assistant engineer in the Iowa State Board of Health.

JOHN CHAMBERS, city engineer, Louisville, Ky., has been appointed chief engineer and superintendent, Louisville Water Co.

R. G. TYLER has resigned as city engineer of Paris, Tex., to become dean of engineering at the University of Oklahoma, Stillwater, Okla.

NEIL M. CAMPBELL, city engineer of Lake Forest, Ill., will open an office in Lake Forest to engage in private engineering and surveying practice, in addition to his duties as city engineer.

L. B. EVENSEN, former city engineer of Great Falls, Mont., has entered consulting mechanical and municipal engineering practice in that city.

L. E. RAYMOND, formerly superintendent of construction with the Turner Construction Co., is now with W. L. Stoddart, architect, in the same capacity.

R. G. MANLEY has been appointed city engineer and superintendent of streets of Upland, Cal.

FRANK MALONEY, from 1911 to 1915 adjutant general of Tennessee, and recently in engineering practice in Knoxville, has been appointed state highway engineer of Arkansas, succeeding V. P. Knott.

L. A. WILSON has resigned as assistant engineer division of highways, State of Illinois, to become a member of the firm of the Clinton Engineering Co., Clinton, Iowa.

THE LA SALLE ENGINEERING CO. has been reorganized by A. B. Boyer and I. A. Baum, under the name of Boyer, Baum & Co., to practice consulting engineering in connection with structural steel, reinforced concrete and timber structures.

J. A. GLOMINSKI, formerly resident engineer New York Central R.R., Buffalo district, is now highway engineer, U. S. Bureau of Public Roads at St. Paul, Minn.

IVAN S. SIEGRIST, designing engineer with Black & Veatch, consulting engineers, Kansas City, Mo., for 5½ years, has resigned his position to take up the business of his father, the Siegrist Engraving Co.

P. G. LANG, JR., formerly assistant engineer of bridges with the Baltimore & Ohio R.R., has been appointed engineer of bridges, with headquarters at Baltimore, Md.

D. M. LAMDIN, division engineer, Atlantic Coast Line R.R., with headquarters at Waycross, Ga., has been appointed engineer of construction.

W. S. HANLEY, since 1912 chief engineer, New Orleans Great Northern R.R., with headquarters at Bogalusa, La., has been appointed chief engineer of the St. Louis Southwestern Ry., with headquarters at Tyler, Tex.

PERRY T. NAYLOR, formerly assistant city engineer, has been appointed city engineer of Hastings, Neb.

THE MARKHART THAYER ENGINEERING CO., Pittsburgh, Pa., has been organized by Prof. H. R. Thayer and C. O. Markhart to take over the business of Brown, Egerman & Markhart, civil engineers and architects.

OBITUARY

CHARLES M. JARVIS died in Atlantic City, N. J., May 21. He was born in Binghamton, N. Y., in 1856 and was graduated from the Sheffield Scientific School, Yale University, in 1877. In 1878 he became draftsman for the Corrugated Metal Co. at East Berlin, Conn. In 1882 the firm name was changed to the Berlin Iron Bridge Co., with Mr. Jarvis as vice-president and chief engineer. Later, he became president and acted in this capacity until the company was merged into the American Bridge Co. Specialties of the Berlin Iron Bridge Co. were the parabolic truss bridge, of which more than 500 were built in New England and New York State, and steel mill building construction. He served one year as vice-president in charge of operation of the American Bridge Co. Later, he became vice-president of P. & F. Corbin, New Britain, Conn., hardware manufacturers. He was instrumental in the formation of the American Hardware Corp., of which he was president. A few years ago he retired owing to ill-health.

COL. THOMAS C. CLARKE, consulting engineer in the coal and coke industry, died May 25 in New York. He was born in Philadelphia, Pa., in 1873 and was graduated from the Massachusetts Institute of Technology in 1893. From 1893 to 1897 he was general inspector and assistant on bridge construction work in Philadelphia and was also associated with John F. O'Rourke in consulting work. In 1902 he became treasurer of the Imboden Coke & Embree Iron Co. and in 1903 treasurer and assistant general manager of the Astoria Steel Co. Later he became general superintendent of the Lackawanna Iron & Steel Co., Lebanon, Pa., in charge of the entire work of five blast furnaces, byproduct coke oven plant, stone quarries, etc. During the World War he attended one of the early Plattsburg camps, from which he was graduated an engineer officer. He went to France as lieutenant-colonel. In France he was promoted to colonel and commanded his regiment in the Argonne Forest. As a result of his participation in a raid which broke through the German lines, Colonel Clarke was decorated with the Croix de Guerre and was cited in American First Army orders. Since the termination of the war he has been vice-president of the International Coal Products Co.

EDMUND T. PERKINS, consulting and supervising engineer and president of the Edmund T. Perkins Engineering Co., Chicago, Ill., died in Chicago, May 21. He was born in Scottsville, Va., in 1861, and was graduated from Union College with the degrees of C.E. and B.A. in 1885 and M.A. in 1888. From 1885 to 1902 he was connected with the U. S. Geological Survey as assistant topographer. In 1888 he did topographical work in Missouri, Kansas and Oregon. From 1889 to 1895 he was in Idaho and, among other work there, ran the reconnaisance lines for wagon roads through mountains and inaccessible regions. From 1902 to 1910 he was with the U. S. Reclamation Service as engineer in charge of Colorado River investigations, preliminary surveys and plans on the Yuma Project, Yuma, Ariz., and later in charge of the Chicago transportation and contracting office. In 1910 he entered private practice as consulting and supervising engineer in Chicago and established the Edmund T. Perkins Engineering Co., which has been successful in developing a number of large drainage districts in Illinois, Iowa and Missouri. He was a member of the Everglades Engineering Commission of the State of Florida with the late Isham Randolph and with M. O. Leighton. He was one of the organizers and the third president of the American Association of Engineers and was for many years president of the National Drainage Congress. He also served as chairman of the engineering committee of the Chicago Chamber of Commerce which has been active in civic matters.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Value of Organized Collection of Business Information

That it will be the task of the Federal Government to co-operate with the press by perfecting its agencies for the collection, organization and dissemination of economic data was one of the points stressed by Herbert Hoover, Secretary of Commerce, in his address before the nation's representative business men at the Hotel Commodore, New York City, last week, the occasion being the 125th anniversary of the founding of the *New York Commercial*.

Referring to trade conditions at the time the *New York Commercial* was established, Secretary Hoover asserted that the inspiration back of the foundation of the paper lay "in the primary necessity for all except the most primitive commerce, to know accurately and promptly the course of the market, the movements of transport, the opportunities of trade, the record of production, and the stocks in hand from day to day." Mr. Hoover asserted that the risk and, therefore, the volume of business depended largely on the accuracy and completeness of commercial intelligence and, therefore, the preparation and dissemination of this information was almost as complex as commerce itself. Though the press had gone far in the collection and distribution of information vital to the safe conduct of business, Mr. Hoover asserted that no one individual or institution could be expected to collect, co-ordinate and disseminate all needed commercial data. He emphasized the need for the extension by the government of agencies for the accumulation of these commercial data and, in co-operation with the daily press, its distribution among men who so vitally need it.

"If the government had maintained an efficient and full service of information of economic trend relating to production, to the stocks of commodities, to their distribution, both at home and abroad, we could greatly have mitigated the height of the last boom and the depth of the present slump," declared Mr. Hoover.

"There is perhaps no complete cure for these booms and slumps, but we can say that they would be infinitely more violent if it were not for the services of information that are at the disposal of the commercial public today through the press, and for such services as the government does perform."

Mr. Hoover said that he was convinced that if the increasing volume of consumption that has steadily grown during the last few weeks throughout the country "could be promptly illuminated to the public, the whole of our commercial community would take courage and would carry us forward with even greater strides than those with which we will now proceed."

Open price associations, he said, in so far as he had investigated them, had originated from a "rightful desire" to secure accurate and complete information of the volume of production on stocks, on consumption and on price.

Road Contracts for May, 1921, Exceed Those of May, 1920

The value of street and road contracts let during the month of May, 1921, exceeded the contracts let during the corresponding month of 1920 by approximately $5,000,000, analyses of contracts let as reported in *Engineering News-Record* indicate. The total value of contracts for street and road improvements during May of this year totaled $35,064,031 whereas during May, 1920, this total was $30,257,872. The value of all contracts let during May, 1921, was approximately 65 per cent of the value of all contracts let during May, 1920, the respective figures being approximately $109,000,000 and $166,000,000.

Street and road improvement was not the only class of construction which set a higher contract figure this year than last, for the contracts awarded during the past month in water-works improvements, excavation and dredging work, and in Federal government work exceeded those let during May, 1920.

VALUE OF CONTRACTS LET IN MAY 1921 AND 1920

Classification	May 1920	May 1921
Waterworks	$1,381,655	$4,943,562
Sewers	2,314,874	2,162,460
Bridges	5,363,709	1,642,894
Streets and roads	30,257,872	35,064,031
Excavation—dredging	403,705	2,631,799
Industrial	39,661,869	7,799,584
Building	70,946,738	48,442,471
Federal government	1,167,045	1,809,588
Miscellaneous	14,373,321	4,408,142
Totals	$165,870,788	$108,904,531

In miscellaneous building construction during May of this year the total contract value amounted to in excess of $48,000,000, whereas during the corresponding period of 1920 the contract value was $70,946,000. However, this latter figure includes the construction of a single $25,000,000 project. A comparison of the value of contracts let for the two corresponding months of 1920 and 1921 is given above.

These are direct comparisons of money involved and do not take into consideration a decrease in the cost of construction work within the year.

Wyoming Votes Road Bonds

On May 10 every county in the State of Wyoming voted to authorize the state to issue bonds in the amount of $1,800,000 for state highway construction work.

Eight Cardinal Principles in Building

Building trades employers, prominent contracting firms, and building trades employees are frequently using the daily newspaper as a means of advertising their particular views of this and that question in connection with wage discussions and business conditions. The Wells Bros. Construction Co. of Chicago and Springfield, Ill., recently carried a double-page advertisement in a Springfield paper in which it was stated that the square deal in building could be found in the eight cardinal principles adopted by the building trades and the construction employers of Chicago twenty years ago.

These eight cardinal principles are as follows: (1) There shall be no limitations as to the amount of work a man shall perform during his working day; (2) there shall be no restriction of the use of machinery or tools; (3) there shall be no restriction of the use of manufactured material, except prison made; (4) no person shall have the right to interfere with workmen during working hours; (5) the use of apprentices shall not be prohibited; (6) the foreman shall be the agent of the employer; (7) workmen are at liberty to work for whomsoever they see fit, that they shall demand and receive the wages agreed upon by the joint board in this trade under all circumstances, and (8) employers are at liberty to employ and discharge whomsoever they see fit.

Brindell's Lieutenant Guilty of Extortion

Peter Stadtmuller, a former lieutenant of Robert P. Brindell, convicted New York labor leader, was found guilty of extortion by a jury in the New York criminal court, May 25. The specific evidence upon which he was convicted was that he had been given money, in return for which construction was allowed to proceed on certain buildings in Maiden Lane, New York City. The penalty for extortion is a maximum of fifteen years' imprisonment, though first offenders may be given indeterminate periods ranging from seven and a half to fifteen years.

Pennsylvania Highway Department Lets Large Contract

The Pennsylvania Highway Department during the past week let contracts for the construction of modern-type highways worth $8,472,465. The money is to be expended in building thirty-five projects. The most expensive job is located in Bucks County and will cost $935,917. Pennsylvania now has more than 700 miles of highways under construction, a large part of which are uncompleted contracts from 1920.

Will Let Contracts for Pacific Coast Logging Railroad

Announcement is made by the California & Oregon Lumber Co., of Brookings, Ore., that contracts will be ready to let not later than June 15 for the whole or part of 14 miles of railroad from the mills of the company in Oregon to the Redwood holdings in northern California. James H. Owen, president of the company, is now completing the cross-sectioning for the line. Construction will include the erection of a deck Howe truss bridge of three 162-ft. spans, several minor bridges, approximately 6,500 lin-ft. of trestle, and the necessary grading.

Price Restrictions Removed from German Semi-Finished Steel

(Berlin Correspondence)

The Iron Control Board, formed in Germany in the first part of 1919 to rectify the tremendous rise in prices, has recently issued new inland prices for pig iron and railway material, and has cancelled existing prices of semi-finished material without making new stipulations. Thus, the Board has renounced its most important function, constituting itself little more than an advisory body. The reservation made with regard to railway material is of small consequence as the only large purchaser is the administration of the state railroads.

Bids to Be Received Soon on Construction of Two Bridges

Bids are being asked for the construction of two large bridges, one a highway bridge and viaduct across the Lehigh River at Bethlehem, Pa., and the other a concrete bridge with a steel swing span over Lake Worth from West Palm Beach to Palm Beach, Fla. Bids on the former will be received June 23 and on the latter June 17. The bridge at Palm Beach will be 1,885 ft. in length of concrete arch type with a swing span of 174 ft.

Work Begins on Memphis Auditorium

Work has started on Memphis' $1,000,000 municipal auditorium and city market, the contract having been let recently for the foundation and basement work. The foundation is to be finished by Nov. 21, 1921. The structure is to be 335 ft. square with arcades on all four sides. Light-colored brick and Bedford stone are to figure in the exterior and Tennessee marble in the interior work. The auditorium is to have a seating capacity of about 12,000 persons.

Building and Loan Associations

According to a report of the secretary of the United States League of Local Building and Loan Associations, there are in the United States 8,633 building and loan associations with assets aggregating $2,519,914,971, an increase of $393,294,581, or 18.5 per cent, during the past year. The total membership is 4,962,919, an increase of 673,593 for the year, or 15.77 per cent. The average amount due each member is $507.75 as against $495.80, the amount shown last year.

Probe of Building Combines by Lockwood Committee Ends

With the imposition of fines instead of prison terms upon building material dealers and others in the building industry convicted of violations of the state anti-trust laws as the chief cause, Samuel Untermyer announced May 25 that he would discontinue all investigations of alleged illegal combinations in the building industry in New York City. Mr. Untermyer, who with agents of the Department of Justice, has requested justices of the State supreme court that heavy prison terms be given those convicted of violations of the state anti-trust laws, made his sudden announcement that the investigations would cease upon learning that Justice Davis of the New York Supreme Court, had imposed fines upon individuals and corporations, members of the Association of Dealers in Masons Building Materails. Ten individuals were fined from $300 to $450 each, and nine corporations from $500 to $4,000. All the defend-

Labor Rates and Conditions Throughout the Country

VERY few changes are recorded since last month. Probably the most optimistic report is from Los Angeles, where few men are idle in the various crafts. In Detroit building construction is quiet, with no strikes, and rates unchanged. Montreal forecasts a possible general reduction of 10 per cent, "to stimulate construction." In Pittsburgh it is expected that contractors will declare open shop if unions do not accept wage cuts of 20 to 30 per cent. New Orleans agreements expire this month, and it is anticipated that the workers will consent to a reduction of the wage scale, in view of the decreased cost of living. Atlanta reports active building of residences and small apartments. Boston bricklayers are still on strike. Until Kansas City joint committee acts, old scale continues.

S means scarce; E, enough; P, plentiful—Higher rates indicated by +, decreases by −

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$0.90P	$0.70P	$1.00P	$0.30P	.....	$1.00P	$0.25P
Baltimore	1.25P	.80P	.87½P	.54P	$0.74P	1.00P	.35P
Birmingham	1.00	.87½	.....	.25@.40	.....	1.00	.20@.25
Boston	.90	.90P	.90P	.60P	.90P	.90P	.55P
Cincinnati	1.25P	1.00P	.70E	.85P	1.00E	1.25P	.35@.40
Chicago	1.25	1.25	.....	.....	.....	1.25	1.00
Cleveland	1.25P	1.25P	1.25P	.87½P	1.10P	1.25P	.87½P
Dallas	1.00P	1.00P	1.00E	.60E	1.00E	1.00E	.50@.75P
Denver	1.37½	1.00	1.00	.75@.81¼	1.00	1.00	.37½@.50
Detroit	1.00P	.80P	.80@.90P	.50@.60P	1.00P	.60@.80P	.50P
Kansas City	1.12½	1.00	1.00	.90	1.10	1.10	.75
Los Angeles	1.25P	1.00P	1.00P	1.12½P	1.00P	1.00P	.75P
Minneapolis	1.00P	.80P	.80P	.65P	.....	.80P	.50P
Montreal	.90P	.65P	.60P	.35P	.....	.65P	.30P
New Orleans	1.00P	1.00P	1.00P	.65P	1.00P	1.00P	.50P
New York	1.25	1.12½	1.25	.87½	1.12½	1.12½	.75@.80
Pittsburgh	1.50P	1.25P	1.12½P	1.00P	1.00P	12.5P	.80P
St. Louis	1.25P	1.25P	1.25P	.85P	1.25P	1.25P	.67½P
San Francisco	1.25P	1.12½P	1.12½P	1.00P	1.12½L	1.12½P	.81¼P

ants had pleaded guilty to violations of the Donnelly anti-trust laws, their cases growing out of investigations made by the Lockwood joint legislative committee on housing.

In announcing his decision, Mr. Untermyer summed up the achievements of the Lockwood committee and outlined some of the constructive measures it is hoped to have enacted. In the first place, Congress probably will be asked to amend the Federal statutes so as to compel presiding judges to impose prison sentences on violators of anti trust laws.

Though the investigation of alleged illegal combinations in the building industry is to be discontinued, Mr. Untermyer will take up, as chief counsel for the committee, the operation of financial influences in the building industry.

Northwest Lumber Production 28 Per Cent Below Normal

Lumber production in the Pacific Northwest region for the week ending May 21 approximated 57,000,000 ft.b.m., according to a bulletin issued by the West Coast Lumbermen's Association. This figure represents approximately 72 per cent of normal production. Shipments for the week were about 64,000,000 ft.b.m., and new business totaled in excess of 67,000,000 ft.b.m.

Australian Contract Awarded Here

According to recent press dispatches the International General Electric Co., a subsidiary of the General Electric Co., has been awarded a $1,875,000 contract for transformers, switch gear, and other equipment, let by the Victorian Electricity Commission for development of coal mining near the city of Melbourne, Australia.

Coal and Ore Movement Increase Car Loadings

An increase of 32,133 in the number of cars loaded with revenue freight during the week which ended on May 14, compared with the previous week, was shown by reports just received by the car service division of the American Railway Association from the railroads of the country. The increase was largely due to increased loading of coal and ore principally for lake movement.

The total for the week was 750,158 cars, which was, however, 92,987 below that for the corresponding week in 1920, but 10,213 more than that for the corresponding week in 1919. Increases during the week were reported in the loading of all commodities except grain and grain products and livestock, compared with the previous week.

During the week 161,782 cars were loaded with coal, which was an increase of 18,459 over the previous week. It was, however, 1,800 cars below the total for the corresponding week last year and 4,100 under that for the corresponding week in 1919. There were also 22,806 cars loaded with ore, or an increase of 9,700 over the week before.

New Hand Drill Developed To Break Pavement

For use in making street openings for gas and water mains, electric cables, street railway tracks and other purposes the Ingersoll-Rand Co., of New York, has placed on the market a paving breaker operated by compressed air from a small portable plant. The device is similar in design to the non-rotating type of hand hammer rock drill. The company makes the following statement regarding the performance of the machine, based on data furnished by a large public service company:

"A good crew of 8 men using hand methods will cut about 80 lin.ft. of 18- to 24-in. width asphalt and concrete in an 8-hr. day. The asphalt averages 3 to 6 in. in thickness and the concrete about 6 in. That means 10 ft. per man per day, or 50c. per linear foot at a $5 wage. Three men with a compressor and two paving breakers cut an average of 300 lin.ft. per day. This costs about 16c. per linear foot when wages, operating cost, interest, depreciation, etc., are all taken into consideration."

Builders in Lockout Against San Francisco Unions

Four counties in central California, in which are included San Francisco, Oakland and the neighboring cities, are now involved in a controversy between the San Francisco Builders' Exchange and the San Francisco Building Trades Council. The "building war" entered its third week on May 23 and had then reached a stage where building operations in the coast metropolis were said to be "paralyzed." The situation grew out of the refusal of the unions to accept a 7½ per cent wage reduction which a board of arbitration decided was fair for seventeen of the fifty-eight building trades craft. Both the builders and the unions had previously approved the personnel of the board and agreed to abide by its findings.

Supply firms closed their places of business for the duration of the tie-up and on May 26 it was estimated that $100,000,000 worth of residence, office and commercial building work had been stopped and that 11,000 men of the building trades were idle. On May 25 the San Francisco real estate board endorsed the stand taken by the builders in insisting that the unions be not allowed to repudiate their agreements.

Monthly Prices of Construction Materials

Ups and Downs of the Market

In the absence of reports from our representative in Seattle, we are quoting the same prices here as last month.

Railway Supplies—Rails, ties, spikes and bolts the same as last month.

Pipe—Cast-iron pipe down $5 in New York. Chicago reports no changes at present, but resale prices $3 below standard quotations, and a reduction looked for at an early date. Steel discounts and prices of sewer and drain tile unchanged.

Road Materials—The decline in road oils continues, although business is reported fair. Oils are down 1c. per gal. in New York. Asphalt in bulk is down $1, to $16 per ton in New York. Other revisions in Los Angeles, Atlanta, Cincinnati and Detroit. Wood blocks down in Detroit. Paving blocks down in Cincinnati and Detroit.

Sand, Gravel and Stone—Sand down in Montreal and Cincinnati, up in Los Angeles. Gravel down in Cincinnati and Los Angeles. Crushed stone down in Los Angeles, up in Cincinnati. In Dallas, crushed stone is $2.80 per cu.yd. f.o.b. cars, and $5 delivered. Stone is down 25c. in both Chicago and San Francisco, while gravel is down 50c. in Chicago and 25c. in San Francisco. Slag prices revised for Easton, Pa., and Buffalo. Crushed slag quotations added for Erie and Emporium, Pa.

Lime—Hydrated down $1 per ton in New York, $2 in Boston, and down in Montreal and New Orleans. Lump down in Boston, Minneapolis and New Orleans.

Cement—Is $2.80 net delivered in New York, $2.40 alongside dock, and $2 at the mills supplying this district. No changes elsewhere.

Common Brick—Down in Boston, Minneapolis, Cincinnati, Detroit, New Orleans, Dallas and Kansas City.

Hollow Tile—Prices are again quoted for New York and the Perth Amboy, N. J., factory. Down in Boston, Minneapolis and New Orleans.

Steel—No changes on structurals or reinforcing. Mill orders light, as is warehouse business also. Black and galvanized sheets a little lower in New York, unchanged elsewhere. Steel interests in Chicago refuse to supply quotations on triangle mesh.

Lumber—Despite a further decline in New York a temporary bottom appears to have been reached in the lumber market in general. Increases in Cincinnati, and revisions in both directions in Minneapolis, down in Baltimore.

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Quotations compiled by The Matthew Addy Co.:

	Current	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25 @ 2.75)	$28.25	$45.60
Northern Basic	26.52	42.80
Southern Ohio No. 2 (silicon 1.75 @ 2.25)	27.62	46.80
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25 @ 2.75)	34.26	49.70
BIRMINGHAM		
No. 2 Foundry (silicon 2.25 @ 2.75)	24.00	42.00
PHILADELPHIA		
Eastern Pa., No. 2X, (2.25@2.75 sil.)	26.26*	46.00*
Virginia No. 2 (silicon 2.25 @ 2.75)	27.00*	45.00*
Basic	25.00†	44.50†
Grey Forge	25.00*	43.50*
CHICAGO		
No. 2 Foundry Local (silicon 1.75 @ 2.25)	23.00	43.00
No. 2 Foundry Southern (silicon 2.25 @ 2.75)	29.67	47.00
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley (silicon 1.75 @ 2.25)	26.46	45.65
Basic	24.46	44.40
Bessemer	26.96	44.90

*F.o.b. furnace. † Delivered

RAILWAY SUPPLIES

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh			
	Current	One Year Ago	Birmingham	Chicago
Standard bessemer rails	$45.00	$45.00		$45.00
Standard openhearth rails	47.00	47.00	$47.50	47.00
Light rails, 8 to 10 lb.	2.30*	3.75*		2.45@3.00*
Light rails, 12 to 14 lb.	2.25*	3.75*	2.20*	2.41@2.95*
Light rails, 25 to 45 lb.	2.20*	3.75*	2.20*	2.32@2.85*

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8½ Ft.	7 In. x 9 In. by 8 Ft. 6 In.
Chicago, White Oak	$1.45@$1.55	$1.55@$1.65
Chicago, Hardwood and Red Oak	1.35@1.40	1.50@1.55
Chicago, Empty Cell Creosoting (add'l)	.45	.50
San Francisco, Green Douglas Fir	.80	1.12
San Francisco, Empty Cell Creosoted, Douglas Fir	1.76	2.48

For ties on standard "railroad administration" specifications, f.o.b. cars, St. Louis:

	White Oak	Red Oak	Pine and Sap Cypress
Grade 3	$1.35	$1.20	$1.10
Grade 2	1.25	1.10	1.00
Grade 1	1.15	1.00	.90

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh				San Fran-
	Current	One Year Ago	Chicago	St. Louis	cisco
Standard spikes, ⅜-in. and larger	$3.30	$4.00	$3.40	$4.50	$5.70
Track bolts	4.35	6.00	4.60	5.60	6.65
Standard section angle bars	2.50	3.50	2.75	3.35	4.50

PIPE

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the Pittsburgh basing card of April 13, 1921:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62½	50	¼	33½	18½
			1 to 1½	35½	20½

LAP WELD

2	54½	58½	15	42½	...
2½ to 6	58½	46	2	30½	16½
7 to 12	54½	41	2½ to 6	33½	20½
13 and 14	45	...	7 to 12	29½	16½

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60½	49	1 to 1½	35½	21½
2 to 3	61½	50			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	52½	41	2	31½	18½
2½ to 4	56½	45	2½ to 4	34½	22
4½ to 6	55½	44	4½ to 6	33½	21
7 to 8	50½	37	7 to 8	24½	12
9 to 12	45½	32	9 to 12	19½	7

STEEL—From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	54%	62½%	50½%
3½ to 6 in. lap welded	49%	58½%	46½%

	Galvanized		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	40%	50%	36%
3½ to 6 in. lap welded	33%	46%	32½%

Malleable fittings, Class B and C, from New York stock sell at net list prices. Cast iron, standard sizes, 20—5% off

CAST-IRON PIPE—The following are prices per net ton for carload lots

	New York					
	Current	One Year Ago	Birmingham	Chicago	St. Louis	San Francisco
4 in.	$68.30	$79.30	$60.00	$69.10	$60.00	$90.90
6 in. and over	58.30	76.30	55.00	64.10	55.00	85.90

Gas pipe and Class "A," $4 per ton extra; 16-ft. lengths, $1 per ton.

CLAY DRAIN TILE—The following prices are per 1000 lin ft.:

	New York					
Size, In.	Current	One Year Ago	St. Louis	Chicago	San Francisco	Dallas
3	$50.00	$35.00	$60.00	$50.00		$55.00
4	60.00	51.00	60.00	60.00	$90.00	65.00
5	90.00	65.00	85.00	80.00	115.00	84.00
6	115.00	90.00	85.00	100.00	150.00	110.00
8	185.00	130.00	100.00	150.00	250.00	181.00

SEWER PIPE—The following prices are in cents per foot for carload lots

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	$0.22	$0.132		0.13	$0.135	$0.13	
4	.22	132	$0.11	13	135	1625	$0.18
5	.34	198		182	2025	195	165
6	.34	198	*.165	182	2025	2275	25
8	.52	308	275	.26	315	325	35
10	.78	462	355	364	4725	455	
12	1.00	594	4675	468	6075	585	80
15	1.50	792	6875	81	81	975	
18	2.18	1.10	935	1.134	1.125	1.365	
20	2.60	1.32	1.2375	1.512	1.35		
22	3.50	1.98			1.80		
24	3.90		1.7875	1.944	2.025	2.34	2.40
27				2.80	3.75	3.25	
30			4.00	3.55	4.75	3.90	
33				4.15	5.50		
36				4.75	6.00		
	3	5		8	12	24	36
Boston	$0.138	$0.207	$0.322	$0.625	$2.08		$5.45
Minneapolis				42	77	2.45	5.66
Denver		.15		30	50	1.95	
Seattle				40	80	2.88	
Los Angeles	.11*	.165*		27	49	1.65	
New Orleans				26	476	1.82	
Cincinnati	.126	.189		.294	.567	1.89	5.025
Atlanta	.11*	.165*		27	4675	1.7875	
Montreal, *delivered*	.30*	.45*		.85*	1.35	4.50	6.50
Detroit	.117	.1755		.27	6345	2.25	5.6375
Baltimore	.13	.195		.31	.585	2.00	
Baltimore, *delivered*				28	44	86	2.84

*4-in., 6-in., 9-in., 30-in. respectively

ROAD AND PAVING MATERIALS

ROAD OILS—Following are prices per gallon in tank cars 8,000 gal. minimum f.o.b. place named:

		Current	One Year Ago
New York, 45% asphalt	(at terminal)	$0.06½	$0.13
New York, 65% asphalt	(at terminal)	.06	.13
New York, binder	(at terminal)	.07	.13½
New York, flux	(at terminal)	.06½	.14
New York, liquid asphalt	(at terminal)	.08	.10
St. Louis, 40-60% asphalt (*f.o.b. Tulsa, Okla.*)		.02¾*	
Chicago, 40-50% asphalt		.06	.08
Chicago, 60-70% asphalt		.06½	.08½
Dallas, 40-50% asphalt		.10	.07
Dallas, 60-70% asphalt		.13	.08
Dallas, 75-90% asphalt		.15	.10
San Francisco, binder, per ton		15.00	2.25

* Freight $21.75 per ton to Whiting, Ind.

ASPHALT—Price per ton in packages (350-lb bbl. or 425-lb drums, and in bulk in carload lots:

	Package	Bulk
New York (Bayonne, N. J.)	$28 00	$16 00
Boston	No quotations	
Chicago	28 50	21 00
San Francisco	21 50	15 00
Dallas	35 00	27 00
Seattle	27 50	
Denver	....	50@70
Minneapolis	....	25 93
St. Louis	sold out for 1921	
Baltimore	40 00	
Los Angeles, *at factory*	22 15	15 00
Montreal	28 00	21 00
Atlanta	33 00	
Detroit (petroleum asphalt)	24 50	20 00
Cincinnati	37 50	31 00
Maurer, N. J. (asphalt)	27@38	....
Maurer, N. J. (asphalt cement)	29@36	25@31

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums. Rebates of about $1 per bbl., no rebate for drums.

PAVING STONE—

New York	5-in. granite	No quotations
Chicago	About 4x8x4 dressed	$3 35 sq.yd.
	About 4x8x4 common	3 00 sq.yd.
San Francisco	Basalt block 4x7x8	65 00 per M
Boston	5-in. granite	4 20 sq.yd.
Atlanta	Granite	2 00 sq.yd.
Detroit	Granite, 26½ blocks per sq.yd.	107 00 per M
Baltimore	Granite	2 25 sq.yd.
Montreal	Granite	130.00 per M
New Orleans	Granite, 4 x 8 x 4	3 25 sq.yd.
Cincinnati	Granite	4 50 sq.yd.
St. Louis	4x8x4 dressed	3 40 sq.yd.
	4x84x common	3 00 sq.yd.
Kansas City	No. 1 Granite	2.90@2.95 sq.yd.

FLAGGING—

New York	Bronx	$0 25	sq.ft.
	Manhattan, 4 ft.	26	sq.ft.
	Queens, 5 ft.	26	sq.ft.
	6x20-in. cross-walk	1 00	lin.ft.
Chicago	18 in. wide	70	lin.ft.

CURBING—Bluestone per lineal foot, in New York, costs 70c. for 5x16 in., 80c. for 5x18 in.; in cargo lots.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York	3	16	$2 51
New York	3½	16	2 78
Boston	3	16	3 45
Chicago	4	16	3 75@4 00
Chicago	3½	16	3 25@3 50
St. Louis	3½	16	3 05
St. Louis	4	16	3 50
Seattle	4	16	Off market
Minneapolis	3½	16	*2 36*
Atlanta	3½	16	2 30
New Orleans	3	16	2 99
New Orleans	3½	16	3 42
New Orleans	4	16	3 85
Dallas	4	18	3 90
Baltimore	3½	16	3 75
Montreal, *delivered*	4	16	4 50
Detroit	3	16	*2 84*
Detroit	4	16	*3 00*
Cincinnati	4	16	3 30
Kansas City	4	16	*2 40*

CONSTRUCTION MATERIALS

SAND AND GRAVEL—Price for cargo or carload lots is as follows, per cu.yd.:

	Gravel 1½ In. Current	Gravel 1½ In. One Year Ago	Gravel ¾ In. Current	Gravel ¾ In. One Year Ago	Sand Current	Sand One Year Ago
New York	$2.50	$3.00	$2.50	$2.50	$1.25	$1.50
Denver	2.00	1.80	1.80	1.80	1.60	1.40
Chicago	*2.25*	2.15	*2.25*	2.15	*2.25*	2.15
St. Louis	1.55	1.78	1.60	1.82	1.60*	1.68
Seattle	1.50	1.25	1.50	1.25	1.50	1.25
Dallas, *delivered*	3.50	2.50	4.00	2.50	3.00	2.00
Minneapolis, *at pit*	2.00	1.50	....	1.35	1.00	.75
Cincinnati	*2.36*	....	*2.36*	1.55	*1.86*	1.50
San Francisco	*2.25*	1.50	*2.25*	1.50	*1.50*	1.50
Boston, per ton	2.65	3.00	2.65	3.00	2.00	3.00
New Orleans	2.85	3.00	....	....	1.65	1.40
Los Angeles, per ton	*1.45*†	1.25	1.45†	1.25	1.35†	1.15
Atlanta, per ton	2.80	2.25	....	2.25	1.62½	1.15
Detroit	2.50	2.50	2.50	2.00	2.50	1.85
Baltimore, per ton	1.40	1.40	1.60	1.60	.70	.80
Montreal, per ton	1.50	1.25	*1.50*	....	*1.25*	1.40
Birmingham	....	3.25	....	3.75	1.43	1.25

* Fine white sand: Pacific, $5 per ton; Ottawa, $6.
† Freight from quarry to Los Angeles is 80c. per ton.

CRUSHED STONE—Price for cargo or carload lots f.o.b. city, unless otherwise, is as follows, per cu.yd.:

	1½ In. Current	1½ In. One Year Ago	¾ In. Current	¾ In. One Year Ago
New York	$1.90@2.00	$1 90	$2 15	$2 15
Chicago	*2.50*	2.15	*2.50*	2.15
St. Louis *delivered*	2.60*	1.90	2.60*	1.90
Dallas	2.80	3.50	2.80	3.50
San Francisco	*2.25*	1.50	*2.25*	1.50
Boston, *delivered*	3.00*	3.00	3.00*	3.00
Minneapolis, *at plant*	2.00	1.50	2.25	1.60
Kansas City†	1.25	2.35	1.40	2.35
Denver	....	3.75	....	3.75
Seattle *delivered*	3.50	3.50	3.50	3.50
Atlanta	2.50*	3.10	....	....
Cincinnati *delivered*	3.24	....	3.24	1.65
Los Angeles	*1.70*†	1.60	1.80*	1.70
Detroit	2.00*	1.75	2.00*	1.75
Baltimore	1.75*	1.60	1.75*	2.00
Montreal	2.00*	1.75	2.10*	2.00

*Per ton. †F.o.b. Joplin, Mo.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plants:

	1½-In.	½-In.	Roofing	Sand
Lebanon or Bethlehem, Pa.	$1 00	$1 00	$2 50	$0 90
Easton or Catasauqua, Pa.	*1 00*	*1 00*	*2 00*	....
Buffalo, N. Y., and Erie, Pa.	1 25	1 25	2 25	1 25
Emporium, Pa.	1 25	1 25	....	1 25
East Canaan, Conn.	1 25	1 35	4 00	1 10
Birmingham, Ala.	1 25	1 25	2 05	1 00
Toledo, Ohio	1 50	1 50	2 35	....
Atlanta, Ga.	....	2 40	....	....
Eastern Pennsylvania and New Jersey	1 20	1 20	2 50	.90
Western Pennsylvania and New Jersey	1 25	1 25	2 50	1 25

Birmingham, f.o.b. pit $1.15 (or $2.75 per cu. yd. on site)

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per 200-Lb. Barrel Finishing	Lump, per 200-Lb. Barrel Common
New York	*$21 00*	*$19 00*	$3 50* – at plant	– $3 30*
Chicago	20 00	....	....	1 75
St. Louis	26 00	20 00	....	2 50*
Boston	*25 25*	*21 25*	*3 50*	*3 25*
Dallas	27 50	25 00	....	3 00†
Cincinnati	17 60	*16 00*	....	13 10‡
San Francisco	25 40	22 00	....	2 25
Minneapolis	29 00	22 00 (white)	*1 80*	*1.50*
Denver	....	3 20 (bbl.)	1 00 (bu.)	....
Detroit	22 00	19 00	2 00†	1 80†
Seattle	27 00	....	3 25	....
Los Angeles	....	30 00	3 00*	3 00*
Baltimore	22 25	17 50	....	12 75‡
Montreal	30 00	....	15 00‡	....
Atlanta	22 50	18 00	1 60	1 40
New Orleans	....	*17 00*	*2 25*	*2 00*

* 300-lb. barrels. † Per 180-lb. barrel. ‡ Per ton.
NOTE—Refund of 10c. per barrel.

NATURAL CEMENT—Price to dealers for 500 bbl. or over, f.o.b., exclusive of bags:

	Current	One Year Ago
Minneapolis (Rosendale)	$2 80	$1 50
Kansas City (Ft. Scott)	1 60	1 60
New Orleans	3 36	3 36
Atlanta (Magnola)	11 00 ton	1 90
Cincinnati (Louisville)	2 75	2 85
Boston (Rosendale)	3 00	....

PORTLAND CEMENT—Current prices are for barrels in carload lots, with cotton bags, to contractors:

	Current Without Bags	One Month Ago Without Bags	One Year Ago Without Bags
New York (delivered)	*$2 80*	$2 90	$3 30
New York, alongside dock to dealers	2 40	2 40	2 35
Jersey City (delivered)	2 89	2 64	2 47
Boston	2 86	2 86	2 60
Chicago	2 17	2 17	2 15
Pittsburgh	2 17	2 17	2 20
Cleveland	2 43	2 43	2 42
Detroit	2 43	2 43	2 28
Indianapolis	2 43	2 43	2 42
Toledo	2 49	2 49	2 28
Milwaukee	2 39	2 39	2 23
Duluth	2 10	2 10	2 20
Peoria	2 45	2 45	2 32
Cedar Rapids	2 51	2 51	2 43
Davenport	2 47	2 47	2 38
St. Louis	2 60	2 60	3 05
San Francisco	3 09	3 09	2 63
New Orleans	3 36	3 36	2 96
Minneapolis (delivered)	2 41	2 41	2 22
Denver	3 10	3 10	2 82
Seattle	3 10	3 10	3 03
Dallas	2 60	2 60	2 15
Atlanta	2 80	2 75	2 70
Cincinnati	2 57	2 57	2 90
Los Angeles	3 21	3 21	3 10
Baltimore (del.) dryland lots	3 58	2 58	3 85
Detroit	2 43	2 43	....
Birmingham	3 05		
Kansas City	2 55		2 56
Montreal	3 44	3 44	3 48

NOTE—Bags 10c. each, 40c. per bbl.

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH by 4-INCH MESH

Style Number	Weight in Pounds	Pittsburgh, Mill	Chicago	Dallas	San Francisco
032	0.022	$0.87	....	$1.15	*1.38*
049	0.028	1.11	....	1.46	*1.76*
068	0.035	1.35	....	1.80	*2.14*
093	0.045	1.73	....	2.30	*2.75*
126	0.057	2.14	....	2.86	*3.42*
153	0.068	2.55	....	3.40	....
180	0.078	2.93	....	3.93	....
245	0.103	3.86	....	5.15	....
287	0.119	4.46	....	5.96	*7.16*
336	0.138	5.18	....	7.32	....
395	0.160	6.00	....	8.00	....

PAVING

036P	0.017	$0.66	....	$0.88	....
053P	0.024	0.94	....	1.24	....
072P	0.031	1.18	....	1.57	....
097P	0.040	1.52	....	2.02	....
049R	0.024	0.94	....	1.24	....
067R	0.031	1.18	....	1.57	....
089R	0.040	1.52	....	2.02	....

Made in 16-, 20-, 24-, 28-, 32-, 36-, 40-, 44-, 48-, 52- and 56-in. width in rolls 150-, 200- and 300-ft. lengths. Galvanized is about 10% higher.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted are as follows:

Gage	Weight	New York Delivered	Chicago	St. Louis	San Francisco	Dallas
27	233	$25.00	$27.50	$29.35	$34.20	$31.55
26	250	26.00	28.90	29.35	....	33.30
25	300	27.00	31.15	32.00	....	36.00
24	340	28.00	33.10	33.90	42.70	37.45
22	450	31.00	....	....	....	43.30

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	New York	Birmingham Mill	Chicago	St. Louis	Dallas	San Francisco
	Warehouse, Uncut						
½ and larger	$2.10	$3.38	$2.35	$3.13	$3.22½	$3.75	$2.35
⅝ and larger	2.15	3.43	2.50	3.17	3.27½	3.80	2.40
¾ and larger	2.20	3.48	2.50	3.23	3.32½	3.85	2.45
⅞ and larger	2.35	3.53	2.50	3.38	3.47½	4.00	2.60
1 and larger	2.60	3.88	2.50	3.83	3.52½	4.45	2.85

*Includes 15c charge for cutting to lengths of 2 ft. and over.

Twisted bars cut to length take extra of 27½c. per 100 lb.

ROLLED FROM RAILS

	Chicago	St. Louis	Dallas		Chicago	St. Louis	Dallas
½ in. and larger	$2.25	$2.25	$4.25	½	$2.65	$2.50	$3.40
⅝	*2.30*	2.30	4.30	¼	*2.65*	2.75	3.45
1	*2.40*	2.35	....	....	....	....	3.50

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common			Paving Block	
	Current	One Month Ago	One Year Ago	3-inch*	4-inch*
New York (del.)	$18.40	$18.40	$33.00	$47.25	$53.50
New York (at dock)	14@*15	15.00	25.00	....	....
Chicago	12.00	12.00	14.00	34.00	....
St. Louis, salmon	15.00†	15.00	16.00	....	....
Denver, salmon	14.00	14.00	17.00	....	....
Dallas	*15.00*	16.00	24.00	44.00	....
San Francisco	18.00	18.00	15.00	....	44.38
Los Angeles	15.50	15.00	13.50	(not used)	
Boston (del.)	*21.00*	21.75	32.00	49.25	57.25
Minneapolis (del.)	17@*18*	18.00	21.00	37.00	43.00
Kansas City	*17.50*	....	22.00	....	....
Seattle	19.00	19.00	15.00	48.00	53.50
Cincinnati	*19.00*	20.00	24.00	*41.50*	....
Montreal (del.)	18.00	18.00	16.00	100.00	120.00
Detroit	*17.50*	18.00	23.00	*41.30*	*44.00*
Baltimore (del.)	25.00	25.00	20.00	40.00‡	44.00‡
Atlanta	12.50	12.00	....	40.00	....
New Orleans	*14.50*	17.50	24.50	....	....

* For paving blocks 3½x8½x3 and 3½x8½x4 respectively. †Hard brick $20.50 in St. Louis. ‡ Vitrified, f.o.b. plant, Baltimore.

HOLLOW TILE—Price per block in carload lots for hollow building tile:

	New York							
	Current on Trucks*	One Year Ago	Chicago	St. Louis building	St. Louis partition	San Francisco	Perth Amboy N. J., Factory
4x12x12	*$0.1196*	$0.11475	$0.1095	....	$0.085	$0.145	*$0.1027*
6x12x12	*.1545*	.153	.1642	....	.085	.21	*.1156*
8x12x12	*.1794*	.204	.1971	....	.095	.29	*.1541*
10x12x12	*.2392*	....	.2463	$2.23	1.26	....	*.2055*
12x12x12	*.3587*	....	.2956	2.66	1.70*	....	*.3082*

*3% per. off for cash

	4x12x12	8x12x12	12x12x12
Boston	*$0.1107*	*$0.2100*	*$0.2900*
Minneapolis	*.084*	*.161*	*.230*
Minneapolis (delivered)	*.092*	*.175*	*.250*
Cincinnati	.069	.148	.202
Kansas City	.115	.207	....
Denver	.09	.16	.23
Seattle	.13	.175	30
Los Angeles factory	.11	.192	23
New Orleans	*.12*	*.215*	.3750
Detroit	.1042	.1853	.2779
Montreal	.20	.30	.35
Baltimore	16	.27	.45
Atlanta	09875	.175	....
Dallas	13	....	....

STRUCTURAL MATERIAL—Following are base prices f.o.b. mill, Pittsburgh and Birmingham together with quotations per 100 lb. from warehouses at places named:

	Pittsburgh, Mill	New York (del.)	Birmingham	Dallas	St. Louis	Chicago (del.)	San Francisco
Beams, 3 to 15 in.	$2.20	$3.33	$2.20	$4.50	$3.32½	$3.23	$4.35
Channel, 3 to 15 in.	2.20	3.33	2.20	4.50	3.32½	3.23	4.35
Angles, 3 to 6 in., ¼ in. thick	2.20	3.33	2.20	4.50	3.32½	3.23	4.35
Tees, 3 in. and larger	2.20	3.33	2.20	4.50	3.32½	3.23	4.35
Plates	2.40	3.33	2.20	4.50	3.32½	3.23	4.50

RIVETS—The following quotations are per 100 lb.

STRUCTURAL

	Warehouse						
	Pittsburgh, Mill	New York, Current	New York, One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in. and larger	$3.70	$4.65	$6.00	$4.88	$4.97½	$6.50	$5.80

CONE HEAD BOILER

½ in. and larger	3.80	4.75	7.10	4.98	5.07½	6.50	5.90
⅝ and ¾	3.95	4.90	7.25	5.13	5.22½	6.65	6.05
⅞ and 1	4.20	5.15	7.50	5.48	5.47½	7.00	6.30

Lengths shorter than 1 in. take an extra of 50c. Lengths between 1 in. and 2 in. take an extra of 25c.

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh, Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$3.00@$3.25	$4.15	$5.25	$5.00	$4.10	$4.95
Cut	....	7.65	7.75	7.75	4.75	5.00

PREPARED ROOFINGS—Standard grade rubbered surface, complete with nails and cement, costs per square as follows at manufacturing points:

	New York			Philadelphia		
	1-Ply l.c.l.	2-Ply l.c.l.	3-Ply l.c.l.	1-Ply l.c.l.	2-Ply l.c.l.	3-Ply l.c.l.
No. 1 grade	$2.15	$2.55	$3.00	$2.05	$2.45	$2.90
No. 2 grade	1.90	2.25	2.70	1.80	2.15	2.60

Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs $2.80 per roll in carload lots and $3.05 for smaller quantities f.o.b. Philadelphia.

Shingles, red and green slate finish, cost $7.95 per square in carloads; $8.20 in smaller quantities, in Philadelphia.

ROOFING MATERIALS—Prices per ton f.o.b. New York:

Tar felt (14 lb. per square of 100 sq.ft.) per roll of 432 sq.ft.	$2.80
Tar pitch (in 400-lb. bbl.) per 100 lb.	2.10
Asphalt pitch (in barrels) per ton	39.50
Asphalt felt (light) per ton	80.50
Asphalt felt (heavy) per ton	84.50

SHEETS—Quotations are in cents per pound in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh, Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$3.10	$4.22½	$4.13	$6.00	$4.25
No. 12	3.15	4.27½	4.18	6.05	4.30
No. 14	3.20	4.32½	4.33	6.10	4.35
No. 16	3.30	4.42½	4.33	6.20	4.45
Black					
*Nos. 18 and 20	3.85	5.30	5.20	6.80	*4.80*
*Nos. 22 and 24	3.90	5.35	5.25	6.85	*4.85*
*No. 26	3.95	5.40	5.30	6.90	*4.90*
*No. 28	4.00	5.50	5.40	7.00	*5.00*
Galvanized					
No. 10	4.00	5.50	5.70	....	*4.60*
No. 12	4.10	5.60	5.80	7.10	*4.70*
No. 14	4.25	5.60	5.80	7.25	*4.85*
Nos. 17 to 21	4.40	5.90	6.10	7.40	*5.15*
Nos. 22 and 24	4.55	6.05	6.25	7.55	*5.30*
*Nos. 25 and 26	4.70	6.20	6.30	7.70	*5.46*
*No. 28	5.00	6.50	6.40	8.00	*5.75*

* For painted corrugated sheets add 30c. per 1000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York		Chicago	
	Current	One Year Ago	Current	One Year Ago
Raw in barrel (5 bbl.)	$0.80	$1.73	$0.75	$1.78

WHITE AND RED LEAD—Base price per pound

	Red — Current		Red — 1 Year Ago		White — Current Dry and In Oil	White — 1 Yr. Ago Dry and In Oil
	Dry	In Oil	Dry	In Oil		
100-lb. keg	13 00	14 50	15 50	17 00	13 00	15 50
25 and 50-lb. kegs	13 25	14 75	15 75	17 25	13 25	15 75
12½-lb. keg	13 50	15 00	16 00	17 50	13 50	16 00
5-lb. cans	16 00	17 50	18 50	20 00	16 00	18 50
1-lb. cans	18 00	19 50	20 50	22 00	18 00	20 50

500-lb. lots less 10% discount. 2000-lb. lots less 10-2½% discount.

LUMBER

San Francisco—Prices of rough Douglas fir No. 1 common, in more than carload lots:

	Lumber Prices in Yards at San Francisco — 6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$24 50	$25 00	$26 00	$28 00
3x6 and 8	25 50	26 00	27 00	29 00
4x4-6 and 8	26 00	27 00	28 00	29 50
3x10 and 12	26 00	27 00	28 00	30 00
3x14	26 50	27 50	28 50	30 50
4x10 and 12	26 00	27 00	28 00	30 00
4x14	27 00	28 00	29 00	31 00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$25 50	$27 50	$28 50
6x14	27 00	29 00	29 50
8x10	25 50	27 50	28 50
8x14	27 00	29 00	29 50

New York, Chicago and St. Louis

	Southern Pine — New York* — 20 Ft. and Under	New York* — 22-24 Ft.	Chicago — 20 Ft. and Under	Chicago — 22-24 Ft.
3x4 to 8x8	$43 00	$45 00	$48 00	$49 00
3x10 to 10x10	48 00	50 00	50 00	51 00
3x12 to 12x12	43 00	45 00	53 00	54 00
3x14 to 14x14	48 00	50 00	57 00	58 00
3x16 to 16x16	55 00	56 00	62 00	63 00
3x18 to 18x18	62 00	63 00	66 00	67 00
4x20 to 20x20			69 00	70 00

* For long leaf pine. Short leaf pine up to 14 x 14 costs $15 per M. less.

St. Louis—Yellow pine, 22@24 ft. long, 3 x 12@4 x 12, $42; 2 x 16, $53; 3 x 16 @ 8 x 16, $53; 6 x 10@8 x 10 to 10 x 10, $37; 6 x 12@8 x 12 to 12 x 12, $41; 6 x 14@8 x 14 to 14 x 14, $45; 6 x 16@8 x 16 to 16 x 16, $51.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 30 ft. for sizes 12x12 and under, for sizes over 12 x 12 add $2 for merchantable add $2 to sizes 10 x 10 and under. For pine add $2 to the price of merchantable for all sizes.

Other Cities

	8 x 8-In. x 20-Ft. and Under — Fir	Hemlock	Spruce	12 x 12-In. 20 Ft. and Under — Fir	Fir
Boston	$45 00	$53 00	$55 00	$50 00	$55 00	$56 00
Seattle		25 00				27 00
New Orleans	35 00				38 00	
Baltimore	55 00				68 00	
Cincinnati	**50 00**	**50 00**			**65 50**	64 00
Montreal	78 00	85 00	68 00	78 00	78 00	100 00
Los Angeles		47 00	46 00			49 00
Detroit	Quotations f.o.b. mills only					
Denver		37 25				38 25
Minneapolis	43 00	48 00	34 00		51 00	55 00
Atlanta	27 50				40 00	
Dallas	35 00				40 00	
Kansas City	**34 00**	**35 00**			**39 00**	37 00

	1-In. Rough, 10 In. x 16 Ft. and Under — Fir	Hemlock	2-In. T. and Gr., 10 In. x 16 Ft. — Fir	Fir
Boston	$45 00	$53 00	$50 00	$43 00	$48 00
Seattle		18 50			
New Orleans	55 00			35 00	
Baltimore	42 50			40 00	
Cincinnati	**70 00**	80 00		**40 00**	
Montreal	120 00	60 00	60 00	80 00	80 00
Los Angeles		41 00	40 00		51 00
Denver		31 25			29 25
Minneapolis	45 00	**33 25**	33 25	**36 00**	31 75
Atlanta	45 00			18 00	
Dallas		30 00		35 00	
Kansas City	40 00	40 00			

* Montreal—Up to 32 ft., over which, $3.00 per M. increase up to 30 ft.

Birmingham—Dimension and form lumber delivered on building site, $26 @ $28. For 8x8x20 and smaller, 85 per cent heart, $33; 12x12x20 and smaller, 85 per cent heart, $42; 1x10x16 and smaller, rough, $16; 2x10x16 t. and g., $22, f.o.b. mill.

Detroit—General quotations not available. Rough fir, 2 x 12 and 2 x 4, by 16 ft., $44; 3 x 12 x 16 ft., $46.50.

FREIGHT RATES

On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.

Baltimore	$0 33½	Detroit	$0 33
Birmingham	76½	Kansas City	81½
Boston	41½	New Orleans*	51½
Buffalo	29½	New York	38
Chicago	38	Pacific Coast (all rail)	1 66½†
Cincinnati	33	Philadelphia	35
Cleveland	24	St. Louis	42½
Denver	1 35*	St. Paul	69½

Note—Add 3% transportation tax. * Minimum carload, 40,000 lb. Minimum carload, 50,000 lb., structural steel only; 80,000 lb. for other iron or steel products.

CONTRACTORS' SUPPLIES

STEEL SHEET PILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Current	One Month Ago	One Year Ago
$2 55	$2 55	$2 55@$3 65

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	New York
Hercules red strand, all constructions	20
Patent flattened strand, special and cast steel	20
Patent flattened strand, iron rope	5
Plow steel round strand rope	35
Special steel round strand rope	30
Cast steel round strand rope	25
Iron strand and iron tiller	5
Galvanized iron rigging and guy rope	+ 12½

San Francisco: Galvanized iron rigging and guy ropes + 17½%; bright plow, 30% off.

Chicago: Plow steel, round strand, 30% off; flattened strand, 15%; cast steel round strand, 17½%.

Western and California territory, 30% plow steel; +17½% galvanized iron rigging and guy rope.

Montana, Idaho and Arizona, 25% plow steel; +22½% galvanized iron rigging and guy rope.

MANILA ROPE—For rope smaller than ½-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft. there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¾-in., 8 ft.; ⅞-in., 6; 1-in., 4½; 1⅛-in., 3½; 1¼-in., 2 ft. 10 in.; 1⅜-in., 2 ft. 4 in. Following is price per pound for ¾-in. and larger, in 1200-ft. coils:

Boston	$0 [illegible]	New Orleans	[illegible]
New York	18½	Los Angeles	18
Chicago	21	Seattle	20
Minneapolis	[illegible]	St. Louis	21
San Francisco	19	Montreal	40
Atlanta	[illegible]	Detroit	21
Denver	23	Baltimore	25
Cincinnati	22	Kansas City	20½
Dallas	29		

*780 ft. coils.

EXPLOSIVES—Price per pound of dynamite in small lots and price per 25-lb. keg of black powder.

	Low Freezing 20%	Gelatin 40%	Gelatin 60%	Gelatin 80%	Black Powder
New York		$0 37½	$0 36½		
Boston	22½	24½	28½	$0 36½	
Kansas City	24½	28	31½	35½	$2 60
Seattle	18½	20½	22½	29½0	2 60
Chicago	22½	24½	26½	33½	2 50
Minneapolis	22½	24½	26½		2 80
St. Louis	24½	28	31½	35½	2 50
Denver	22½0	25½0	29	33½	2 70
Dallas	26½*	29	32½		2 90
Los Angeles	22	27	32		3 10
Atlanta	25½	28½†	32½	36½0	2 60
Baltimore	25½	28½	31½	36½	2 50
Cincinnati	24½	26½	28½		2 65
Montreal	30	32	37	38	4 10
New Orleans	25½	27½†	30½†		2 80
Birmingham, delivered	15½	19½	22½	27	2 10

* 30 Per Cent. † Low freezing.

PILES—For spruce and plain pine piles, delivered New York, the price is as follows:

Spruce 10-in. butts, 5-in. tops, length 20-30 ft.	$11 50
Spruce 12-in. butts, 6-in. tops, length 30-40 ft.	10 50
Pine 12-in. butts, 6-in. tops, length 41-50 ft.	13 75
Pine 14-in. butts, 6-in. tops, length 51-60 ft.	22 50
Pine 14-in. butts, 6-in. tops, length 61-71 ft.	25 25

	Dallas		St. Louis
6-in. x 20-ft.	$4 60	6-in. x 30-ft.	$7 90
		7-in. x 30-ft.	10 10
6-in. x 30-ft.	7 10	7-in. x 35-ft.	13 55
		8-in. x 35-ft.	16 55
8-in. x 30-ft.	8 45	7-in. x 40-ft.	16 05
		8-in. x 45-ft.	27 05
8-in. x 35-ft.	10 38	8-in. x 50-ft.	28 05

SCRAP—The prices following are per gross ton paid to dealers and producers in New York. In Chicago and St. Louis the quotations are per net ton and cover delivery at the buyer's works, including freight transfer charges.

	New York	Chicago	St. Louis
No. 1 railroad wrought	$10 50	$10 25	$11 00
Stove plate	10 50	13 00	11 50
No. 1 machinery cast	17 50	13 75	15 00
Machine shop turnings	3 50	5 50	5 00
Cast borings	4 25	7 00	7 00
Railroad malleable cast	8 50	12 00	12 50
Re-rolling rails	10 00	13 00	13 00
Relaying rails	41 00	35 00	35 00

SHIP SPIKES—Current prices per 100 lb.

In.	San Francisco — Galv.	San Francisco — Black	Seattle Black
½	$9 10	$8 40	$8 55
⅝	8 65	6 65	8 25
¾	8 50	6 50	8 30

Pittsburgh base, $2.40@$3.65 per 100 lb.